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Choosing a Career

THIS is the time of the year when freshmen in technical colleges are trying to decide what branch of engineering will be best for them to follow. They are handicapped by lack of knowledge as to the qualifications for and the opportunities in each of the several fields and they find it difficult to make an intelligent decision as to their future. Undergraduates, as a rule, place far too much importance on the making of such decisions so early in their careers. The matter can well be dismissed for a year or two and thought given to the fundamental requirement for success in engineering work. This was well expressed by President Maclaurin in a recent address to the incoming class at the Massachusetts Institute of Technology. "Do not worry too much about the choice of a subject," he said. "Success can be attained equally well in any line of work, for out of every course can be derived the two essentials of future advancement—the right method of attacking a problem and the right spirit in which to undertake work." The young technical student who takes this sound advice to heart need not be uneasy as to the wisdom of casting his lot with the civil, mechanical, electrical or mining engineers.

Hell Gate Arch Closed

THE closing of the Hell Gate arch of the New York Connecting Railroad on Sept. 30 and Oct. 1 marked the end of the most difficult part of the erection work on the longest arch span ever built. The precision and ease with which the closing members were set and the saddles under the erection ties lowered till the two parts of the arch came to an accurate bearing were so great that to those fortunate enough to witness these operations any sense of the unprecedented character of the achievement was almost lost. The engineers and erectors deserve the heartiest congratulations on building the heavy arch and swinging it with as little fuss and complication as if it had been an ordinary span. In erection work of this magnitude telephones are a practical necessity. It is difficult to see how the Hell Gate span or the Quebec bridge could be built without them. The increasing attention being paid to the workmen's safety and convenience in building large bridges has been commented on before. It will be seen from the photographs published on another page of this issue that the men who guided the closing sections into place had safe, solid platforms and runways from which to work. This fact undoubtedly contributed largely to the remarkable record made in setting these bottom-chord sections in 25 min. each. The Hell Gate arch will connect two of the country's great railway systems, the Pennsylvania and the New Haven, thus linking the New England territory with the trunk lines serving the West and South. With the completion of the New York Connecting Railroad and the Seventh Avenue subway, the Pennsylvania's comprehensive plan of terminal improvement, adopted thirteen years ago, will be concluded.

New Lock Gate Design

TWO YEARS' OPERATION has demonstrated convincingly the advantages of the new type of submersible gates used at the Keokuk lock. The article by B. H. Parsons, which appears on page 446 of this issue, not only explains the many unusual features, but makes it clear that the special conditions found at the site must govern the selection of such gates and should be considered in all installations of gates of this type. The height from gate sills to the clean-swept bedrock was unusually large—31 ft.—and made possible the vertical movement of the gate without interference from silt. Control by compressed air and buoyancy chambers was adopted because of the compressed air plant available near the gates. The duplication of the gates and provision for interchange with the dry-dock gate or the guard gate make practically continuous operation certain, even if accidents should temporarily put one gate out of commission. It is evident that the designers exercised the greatest care and forethought in devising the details of the Keokuk work, and the successful record in operation should give them considerable satisfaction in having developed a new and satisfactory form of gate.

Records of Congress Proceedings

THE value of the bound volumes in which the International Engineering Congress will publish a record of its proceedings has risen markedly in the estimation of engineers since the Congress itself has become history. Not a few of those who attended the sessions commented on this point even before the busy week was well begun, but now that there is a clear perspective of the entire program it is apparent that an importance greater than was at first realized attaches to the permanent records. In many sessions there were present authorities whose views it was greatly desired to hear at first hand under conditions where open discussion was possible. To allow time for expressions of opinion from the convention floor it often seemed wise to reserve for the bound volumes the written discussion which had been submitted. To this material will be added the revised and amplified discussion that took place at the convention as well as that which was contributed after the sessions were over. In order to crowd into one week about 200 papers it was necessary to arrange a certain number of simultaneous sessions and naturally some interests overlapped. Although the committee of management made every effort to have an ample supply of printed copies of the papers on hand at each session it was not always possible to do this—some papers came in late and others were in such demand that the supply was exhausted so that, all things considered, a complete set of papers bound with all of the revised and co-ordinated discussion will be a most valuable addition to the library of every engineer. The demand will be greatest among those who attended the Congress and sensed its spirit.

Erie's Opportunity

IF the city of Erie, Pa., puts into effect the flood-prevention plans outlined on page 440, a repetition of last August's disaster, in which Mill Creek overflowed its banks and surged through the streets, sweeping buildings and bridges before it, will be impossible. Erie knows what a flood means, and now is the time to begin construction on the project of channel improvement and stream control recommended by Farley Gannett. The plans, in brief, propose sections of closed conduit and open, concrete-lined channel in place of the present stream bed, which is restricted by encroaching structures of all sorts; substitution of easy curves for all sharp bends, and construction of a dry detention reservoir some distance above the city to impound extraordinary flood flows. Neglecting entirely the humanitarian aspects of the problem it is good business for Erie to build the proposed works, for another flood would cost much more than the preventive measures recommended. Erie, to-day, is in much the same position as was Galveston after the hurricane which almost annihilated the city in 1900. But Galveston had learned its lesson and wisely built a sea-wall, which, as the results of the recent tropical storm prove, was a potent factor in reducing the damage to a minimum. Galveston, with its sea-wall, and Erie, with its flood-prevention works, will be in much the same position as men with paid-up life insurance policies. They need have no anxiety about the future. With an election coming along next month the City Council should lose no time in taking the steps necessary to submit to the people of Erie a proposal for a bond issue for flood prevention works. Another point well worth considering is that, with financial conditions as they now exist, it will be a long time before the proposed works can be built as cheaply as at present.

New Railroad Link Ordered

FOR THE FIRST time in the history of the State of California the Railroad Commission has ordered the construction of a railroad. The Santa Fé system is directed to build a line with a minimum length of 12 miles and an estimated cost of $657,000, to be completed within fifteen months. Many years ago several clubs and chambers of commerce in San Diego and Riverside counties gave a predecessor company a bonus of land and money worth several million dollars to build a railway from San Diego through Riverside into San Bernardino County. The line was built in 1884 and operated until 1891, when 12 miles, from Temecula to Fallbrook, about midway of the line, were washed out and never rebuilt. This has left two disconnected spurs, and through business has to find some other route.

The recent proceedings were to determine whether or not the railway had fulfilled the obligation attached to the bonus, and the commission decided that it had not. While the railway must replace the missing link, the commission recommends that it be done by a 33-mile line reaching territory not touched before. This journal does not know the details of the case and has no criticism for the commission, which had the facts before it. The matter does, however, suggest nice questions of obligation under circumstances that might have existed.

The fact that the washed-out section was not immediately rebuilt suggests that the line had not proved profitable in the seven years of operation. If not, whence would have come the money to rebuild the 12-mile link? Even though the original bonus was far in excess of the cost of the 12 miles it had, presumably, all gone into the construction of the whole line, and what had not been washed out was still in existence and in operation. Obviously the commercial organizations would never have made their donation except for a permanent railroad, but did they or did they not assume risk of destruction of the property? And should the owners of a losing proposition be compelled to raise, or try to raise, more money to lose?

Again, what should be the responsibility of a successor company, if it acquired the property many years later, mainly for the purpose of utilizing certain parts of it in connection with other lines—taking the whole property in order to get these parts? If the remaining tangible evidence of the bonus was confined in the main to right-of-way, grading and track of unprofitable spurs, should the purchaser be obliged to draw from its other resources to fulfill this old obligation?

Turning back from the hypothetical to the actual case, the future career of the property will be worth following. Will the public authority that compels the reconstruction guarantee a fair return on the cost? Or, if the investment proves unprofitable, will the regulators, in the course of time, justify this fact by the easy explanation that the road ought never to have been built? It is to be hoped that the Santa Fé will be able so to keep its accounts as to show just how the line is faring.

Why the Lumber Industry Is Sick

DECREASED consumption and unregulated production are blamed as the two primary reasons for the present unprofitable and wasteful condition of the lumber industry in all sections of the country. These bald facts are set forth by the National Lumber Manufacturers' Association, which has compiled exhaustive figures of stumpage values, itemized costs of production and realization for lumber at the mills. The decrease in consumption is partly explained by the general depression in business during the past year; the popular belief in the diminishing supply and the advancing price of lumber, which has encouraged the exploitation of many other building materials to take its place; the attacks upon lumber in the name of fire elimination; the lack of advertising of lumber and its uses; the cessation of lumber exports and the removal of duty on foreign lumber.

These depressing conditions, according to the association, are gradually being corrected. General business conditions are on the upturn, and vigorous campaigns of education, advertising and promotion are being conducted to impress the public with the abundance of standing timber and the cheapness of lumber. Literature concerning its proper uses and intrinsic merits is being prepared by trained engineers and extensive laboratory tests are being made. The causes underlying the disastrous overproduction of lumber during the last year, however, are much more fundamental and much less susceptible of betterment under the existing organization of the industry and the present interpretation of federal statutes. The pressure of liquidating stumpage, the incomplete and often misleading methods of figuring costs of production, the necessity of continuous operation of plants forming the industrial support of dependent communities, the present lack of legal means for comprehensive and effective regulation of supply to meet the existing demand, the lack of a general knowledge of the actual condition of the industry by the individual members, and the inherited optimism of past years have all contributed to this overproduction of lumber.

The manufacturers of lumber have presented this situation openly and frankly to the Federal Trade Commission with the hope of receiving constructive aid in overcoming the adverse conditions brought to light, and the national association has sought to give this frank presentment of the industry the widest publicity by publishing full reports of the hearing in Chicago. There has been some criticism of this course by critics of the optimist class, who claim that such publicity has hurt lumber credit, but it is believed that the frank and honest statements made by representatives of the industry have won for it the respect of the financial world, have tended to eliminate speculative ventures, have prevented a great loss to individual operators, actual and prospective, by the information thus presented, and that at least an appreciable check on wasteful overproduction now exists. An introspective analysis of the causes of a situation is a large part of the solution, for there will now doubtless come plenty of support to the association in its constructive, educational campaign.

Qualifications of Secretaries

RECENTLY this journal was in receipt, from a member of a local society, of a severe criticism regarding the election of a new secretary. The man chosen was known as a capable constructing engineer, but had not given evidence of special administrative or promotional ability. It was the contention of the correspondent that the secretary of a technical society is, or should be, essentially a promoter and an administrator, and that without demonstrated ability in these lines a candidate should be considered unfit. It was his belief that engineers with these qualifications could be found within the membership of the society, and that the organization was sure to suffer by the election of a calm, dignified gentleman, unimpeachable as to character and engineering achievements, but without the enthusiasm and experience for the promotion work falling to the working head of a technical society.

This journal is in hearty accord with these views. The building of a technical society, and its elevation to a place of prominence and influence in its community are essentially problems of salesmanship, of promotion, of grasping chances to impress the organization upon engineers and the public, of seeing and developing new opportunities for service to its members and its community. It is true that there is other work to be done in a technical society—the planning of committee work, the arrangement of programs and the very necessary financing. But the secretary cannot be expected to do all the work, nor, in practice, does he do it. With the proper enthusiasm and organizing ability he can delegate to others much of his work, and particularly that part, of a technical order, which most of the members of the society are qualified to do. Many local societies might well elect for secretary not a designing, a constructing or a consulting engineer, but one who has apparently abandoned his profession and gone into salesmanship—a sales engineer. Many will fear that a man of this type would develop policies not consistent with the dignity of an engineering organization. There is that possibility, but it can be avoided by careful selection.

Surely no organization would elect as its secretary someone with whom it was not well acquainted. There may be radical men of the salesman type in the society, who must for the organization's own good be passed over, but there will be others of a more conservative mold who nevertheless have the very important selling and promotional points-of-view so necessary for developing the full possibilities of an organization.

Sensational Achievement in Wireless Telephony

THE transmission of speech by wireless over the 4600 miles that separate the great station at Arlington from Honolulu will be likely to rank as one of the big achievements of the twentieth century. It bears the same relation to telephony as did the first wireless messages across the Atlantic to the early experiments of Marconi. It was certainly remarkable enough to have speech transmitted from Arlington to San Francisco, but that the listener quietly sent to Hawaii should have picked up the same impulses at his distant station falls little short of wizardry.

Wave telephony, in fact, impresses the untechnical mind as being about as near black magic as is permissible in this unimaginative age. In very fact it is extraordinary in theory even as in practice. There is something weirdly impressive in the idea of transmitting through space a large amount of electro-magnetic energy at a frequency so high as to produce no sound in the receiver, and yet capable, by its far less rapid variations in intensity, of transmitting articulate speech. It gives even the jaded imagination of the engineer something of a shock to hear a wireless telephone transmitting station tune up for business, the loud singing growing shriller and fainter until at last it fades away into a mouse's squeak and then, quite unheard, continues pouring out a stream of energy into space by the variations of which speech is transmitted.

Oscillations of 30,000 or 40,000 per second can produce no audible effect and the frequency has to be carried even much higher than this before the individual wave lengths become of the order of magnitude usual in long distance wireless telephony; 50,000 oscillations per second means a wave length of 6000 meters, twice what is commonly employed in telegraphy. Thanks to the ingenuity of various inventors there are ample means, and have been for some time past, of getting a large amount of energy at such frequencies radiated from the antennae.

The success of the recent experiments shows clearly that the single really difficult problem of wireless transmission of speech —that is, the control of a sufficient amount of energy by the transmitting device—has been successfully solved, but by what means this has been done has not yet been made public. For several years past it has been possible to get a sufficient output of energy at the proper frequency and the receiving apparatus is relatively a simple matter. To produce, however, a telephone transmitter capable of impressing the necessary modifications of current intensity on a big scale has proved to be a very troublesome matter and the group of engineers who have just won out deserve profound congratulation for their feat.

Obviously wave telephony over great distances will meet the same difficulties as ordinary wireless in the effects of atmospheric conditions, yet it gives a most beautiful solution of many problems of transmission of intelligence. It makes it possible to hold communications with ships over the whole width of the Atlantic and with isolated islands. Inasmuch as speech can be passed on from a wire line to a wireless stretch and then again to the subscriber, one can imagine, for example, calling up a correspondent in Bermuda or the Azores as comfortably as across the street. Of course, messages sent out can, in the present state of things, be heard by anybody who can tune in on the required frequency, which is inconvenient for some purposes. On the other hand, the receiving station can, with considerable success, limit its listening to messages coming from the direction of a particular station. It is quite impossible to forecast the limitations that may serve to hem in the sphere of wireless telephony, but it is most emphatically here as an accomplished fact, and is certain to find very many useful applications. How many time alone can tell.

When Haiti Awakes

IF a stable government should be established in Haiti, as now seems likely, that island will offer one of the most profitable fields for engineering promotion and development known in recent years and, as a corollary, a good field for engineers and contractors. To-day Haiti is practically an undeveloped country—a wilderness. A century and a quarter ago it was one of the most highly developed and richest countries in the West Indies, but the wars of the negro liberation reduced it to a great charnel house, and it has gone backward ever since. Yet it has cities of large population, has natural resources equal to, if not greater, than those of Cuba, which is now almost completely prosperous. In recent years a considerable mileage of Haitian railways have been constructed, an electric lighting system has been put in operation in Port au Prince, a first class wharf has been constructed there and a few spasmodic attempts have been made to pave the streets. Beyond this practically nothing has been done, although the country is credited with a population of over a million.

Many millions of dollars could be spent on sewers, waterworks, paving, street railways and other municipal works in Port au Prince alone, and yet not bring it up to the standard of improvement to which its hundred-thousand population entitles it. Aux Cayes, Jeremie, Jacmel, St. Marc, Gonaives and Cap Haiten are all seaports of importance. All of them are in crying need of wharves and other improvements. There are lands for sugar growing, but hardly any mills, vast tracts for coffee and fruit growing, but few facilities for getting the products to market, and great forests of valuable woods, equally hampered by lack of means to utilize them. Given a period of rest from incessant revolution, Haiti can pay the bill for its improvements.

The coffee alone, if properly cultivated, could support the entire country. Sugar-growing possibilities are vast and the forests are rich in such woods as mahogany and lignum vitae. Added to these resources are mineral deposits, which, though not so certain in quantity, are sufficiently in evidence at least to justify investigation. The population is, at heart, industrious and mentally alert. Lack of incentive has held it back for many years and has seemingly smothered these qualities entirely, but they could be easily quickened into life. Haiti is ripe for development in which the civil engineer should play no small part.

Chicago Building-Code Violations Getting Publicity

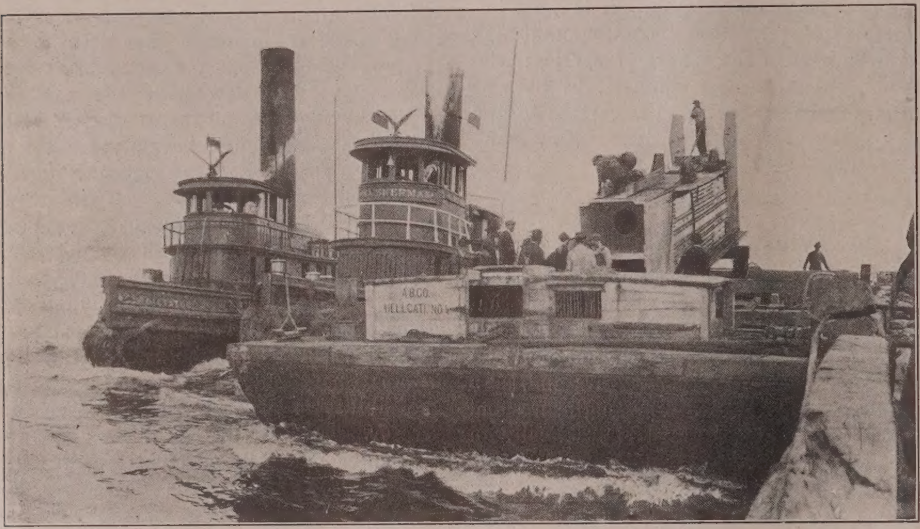
THE FIRE-STOP clause in the Chicago building code is in a fair way to be enforced, for a special educative effort is being made to bring to the attention of the public the reasons for the stops at floor levels and show how little the point is heeded by the building inspectors. Former building commissioners have pleaded lack of inspection force whenever vigorous appeals have been made to see that all the provisions of the code are carried out. As yet no adequate reason has been given in Chicago for disregarding in so many cases a really troublesome detail in building construction. The *American Lumberman* of Sept. 4 reports an elaborate investigation of apartment buildings and finds the responsibility is largely with the mason contractor. The architect, if a bona fide one is employed, usually covers the point in a general way, requiring the contractors that work on the building to observe all rules and regulations of the city. Occasionally it has been found that a specification will repeat in substance the specification in the code. The latter reads as follows: "In buildings of every class where wood furring is used on brick walls, the brick between joists shall be projected from the bottom of the joist to the top of the joist for the full thickness of the furring, and in no case shall such projection be less than 2 in." The idea is to seal off each vertical space between furring strips at every floor level so that any fire which starts in a lower floor will not be provided with a continuous flue from basement to attic. If proper stops are built the fire will often languish from lack of oxygen, and be confined to the locality of its origin.

The National Board of Fire Underwriters is initiating an active campaign in an endeavor to educate the general public in good fire-resisting construction. A series of illustrated pamphlets dealing with details of such construction for various classes of buildings is being prepared. While many of the activities of the association in the past have been directed toward the displacement of wood in the endeavor to effect a fireproof structure, it is highly important that fire-resisting methods of construction be promoted vigorously. Many buildings, with exterior walls only of material other than lumber, come within the fire limits. Since records show such high percentages of fires starting within, building departments can serve the public in no better way than in a strict carrying out of such fire-preventive measures as are contained in their code.

World's Longest Arch, Across Hell Gate, New York City, Is Closed and Swung as Planned

Closing Bottom-Chord Sections Set September 30 in Record Time—Lowering Jacks Under Erection Backstays Next Day Brings Arch to Bearing—Floor System to Be Placed as Backstays Are Dismantled

AT TEN O'CLOCK on the morning of Sept. 30 the south bottom-chord section forming the first connection between the east and west halves of the 977½-ft. Hell Gate arch of the New York Connecting Railroad in New York City, the world's longest arch span, was fitted into place with 3½ in. to spare on its west end. The member was raised and set in 25 min. by the two travelers which had built each side of the arch. This time was 10 min. less than the best time made in erecting any previous section of the bottom chords. Shortly after noon the closing member for the north truss was successfully set in the same length of time, although the hot sun had expanded the bridge till there was less than 2 in. clearance in which to manipulate the 90-ton chord section.



LAST CHORD SECTION, ASSEMBLED WITH GUSSET PLATES, WEIGHED 90 TONS

The two diagonals from the top of the east side of the panel to the bottom of the west side were next set with half the diagonals from the bottom of the east side. The closing panel is a true center panel, and the temporary hinged bearing that will support the arch till the full dead load is being carried is in the bottom chord at the west end of this panel.

TELEPHONES SYNCHRONIZE WORK

On Oct. 1 the jacks on the main posts of the backstays, which rest on the two main piers, were lowered varying distances from 15 to 20 in. to bring the center hinge to a bearing. This operation was successfully accomplished and the eyebar ties over the backstay posts were released in about 1¼ hr. through the use of a multi-party telephone line with stations at the center, at each backstay jack, at each counterweight and at the office. Men stationed at all these points were thus kept continually informed of all relative movements, each station being directly connected with all the others, and all "listening in" to the orders and reports from each of the points. Previous calculations of the required movements at each jack had been made to insure even lowering at the top hinges so that no appreciable shear would be transmitted through the center chords. Scales adjusted to allow for the unsymmetrical lengths and weights of the two cantilever halves were placed beside the jacks, and the lowering operations thus were made absolutely uniform and exact.

The erection of the backstay material on the Ward's Island end began about Feb. 1, and about June 1 the shoes were set and the erection of the arch proper progressed continuously without any effort at record-making for the four months until closure on Oct. 1. No lives were lost in this operation; safety and accuracy were considered of primary importance throughout. The total weight in the arch as now erected is about 13,000 tons, and there are about 23,000 tons in both backstays and anchorages. When completed with hangers and floor system in place there will be nearly 20,000 tons of steel in the arch span.

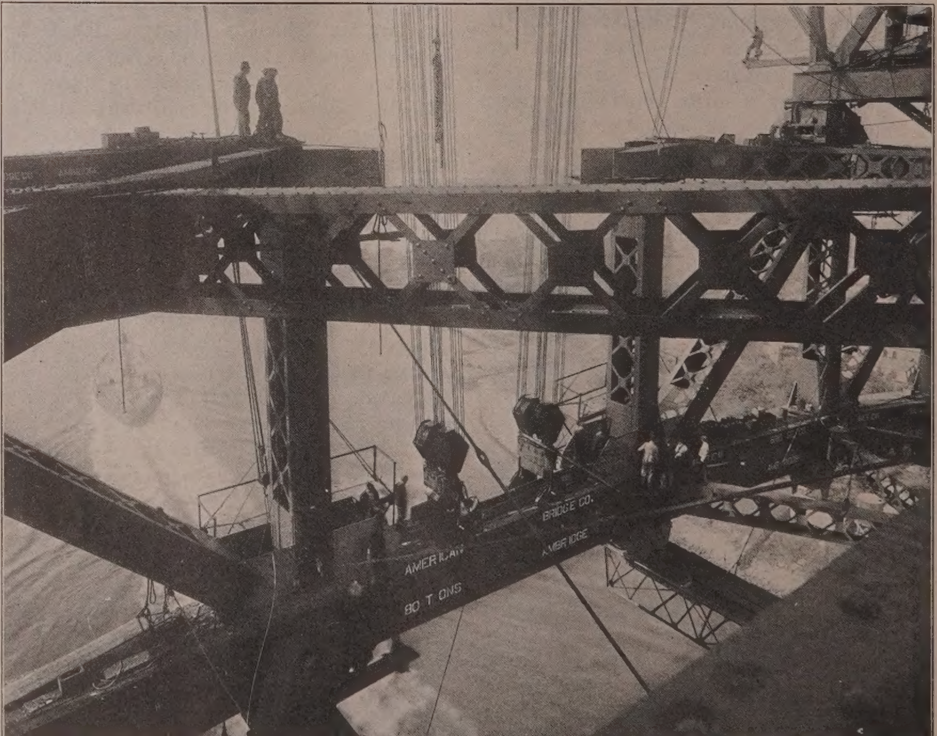
ADJUSTMENT BOLTS FOR TOP CHORDS

The east ends of the top-chord sections in the center panel were at once riveted up, but the west ends will be left free to move until the arch has reached its final position under full dead load. These ends slide on shelf angles on the east end of the last top-chord members of the west half of the arch. In order finally to match up this panel point it was thought best to leave one pair of members blank and drill them by the other pair after the arch was under full dead load.

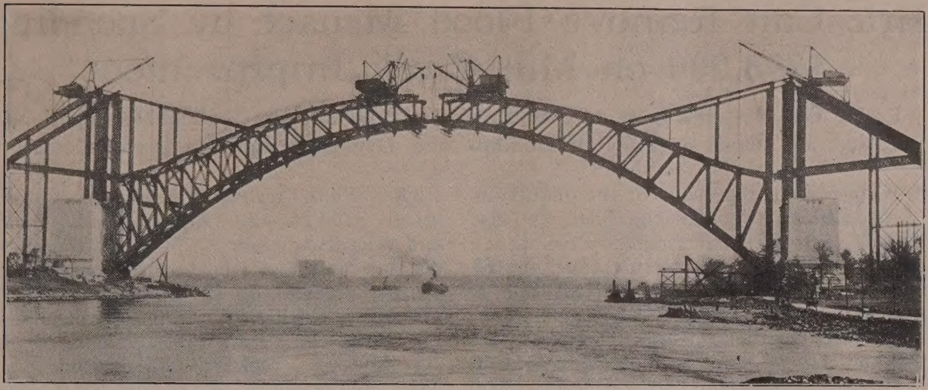
As temperature changes on any ordinary day would throw this work out of alignment before holes could be drilled to insert enough drift pins to withstand the temperature stresses, some means had to be provided for holding the top-chord sections rigid at this panel point. This is accomplished by a 7-in. diameter bolt inside of each top-chord section parallel to its center line. The end of one of these bolts is shown in an accompanying photograph. The nuts on these huge bolts engage diaphragms in the top-chord sections of the panel west of the center. These bolts are strong enough to take all temperature stresses and hold the ends of the top-chord sections rigid till they can be drilled and riveted.

DRIFT PINS HOLD BOTTOM CHORDS

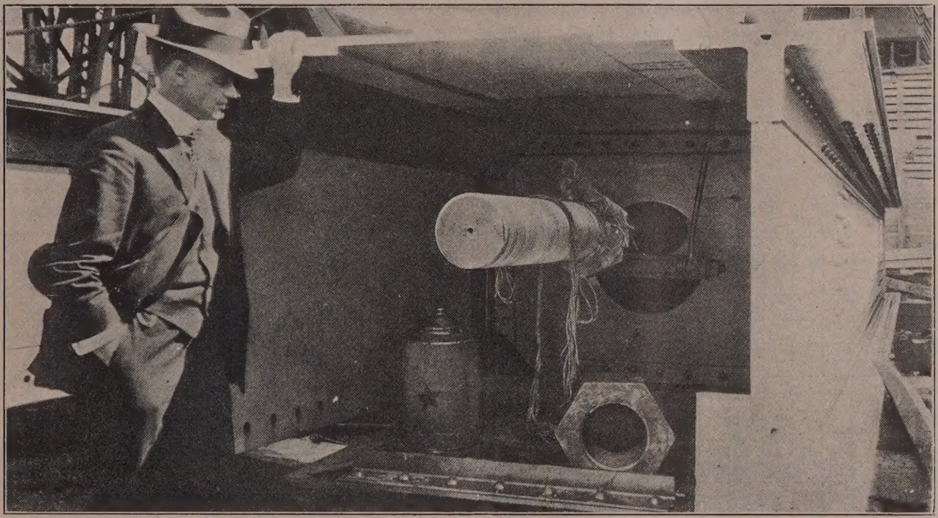
As the dead load stress is carried by contact joints in the bottom chord, it was



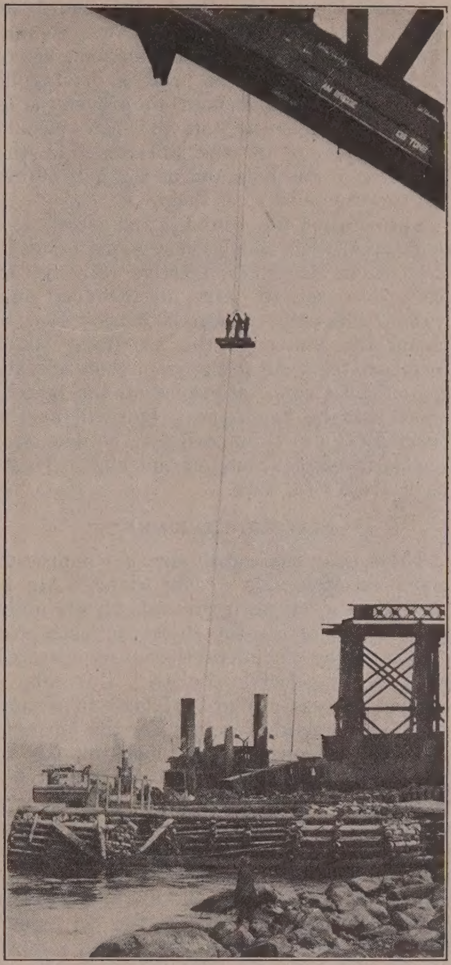
SECTION BEING RAISED INTO POSITION WITH 3½ INCHES CLEARANCE



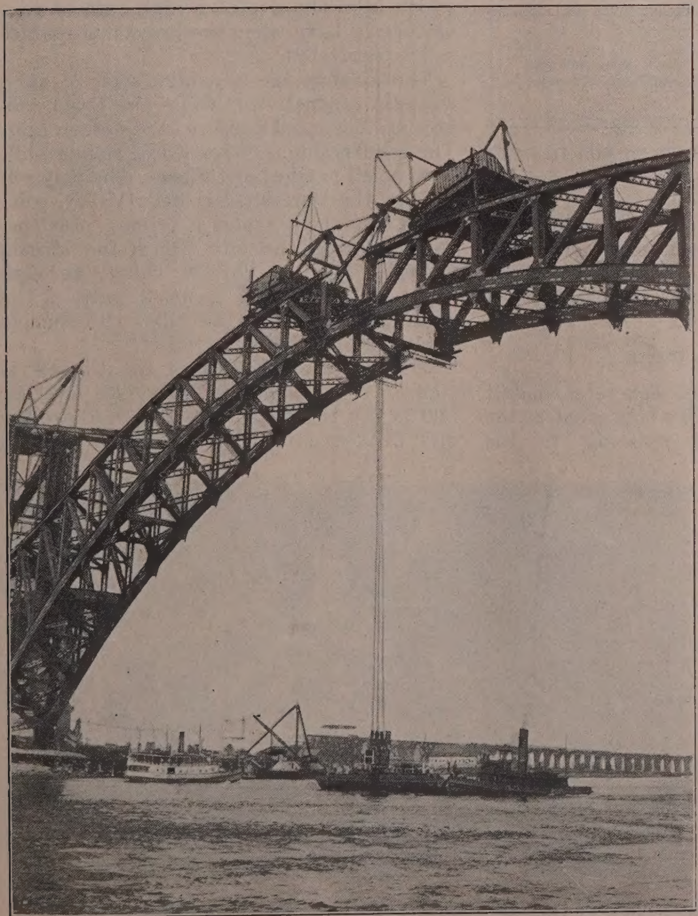
SETTING THE FIRST CLOSING MEMBER IN THE WORLD'S LONGEST ARCH SPAN



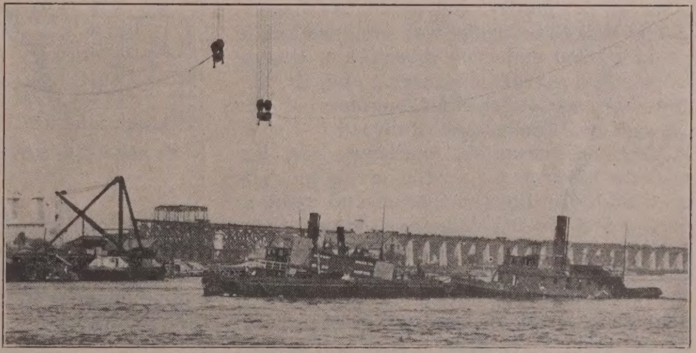
GIANT BOLTS TAKE TEMPERATURE STRESSES WHEN TOP CHORDS ARE CLOSED



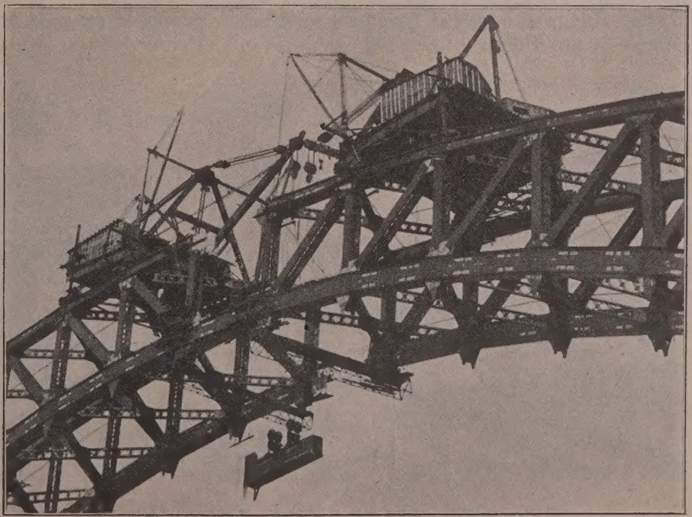
ELEVATOR FOR MEN AND LIGHT LOADS



CHORD SECTION SET IN 25 MIN.—A RECORD FOR THE JOB



FALLS REACHING DOWN FOR LAST BOTTOM CHORD MEMBER



LAST BOTTOM CHORD SECTION NEARS ITS FINAL POSITION not desirable to rivet the bottom chords at the panel points until the arch was swung. Bolts could not be used under such heavy loads. They cannot be made a driving fit nor be tightened enough to prevent slipping. Consequently, all the holes would have been out by the difference in the diameter of the hole and of the bolt before the time came to rivet them.

The solution was found in the use of steel drift pins, with which every panel point in the bottom chord now bristles. Enough of them are used to carry all the dead load stress, and only enough bolts are used to clamp the plates of the adjoining chord members together and prevent their spreading under stress. Riveting on the bottom chord will be begun now, but will not be carried far until the steel for the floor system is in place. Some of the 1¼-in. rivets used are 11 in. long.

ELECTRIC EQUIPMENT

There is an electrically driven compressor plant on each side of the river. Air is piped to the riveters through an air main at the level of the top chord for each side of the arch. The travelers are operated entirely by electric hoists. Current is carried across to Ward's Island in a submarine cable laid especially for the job.

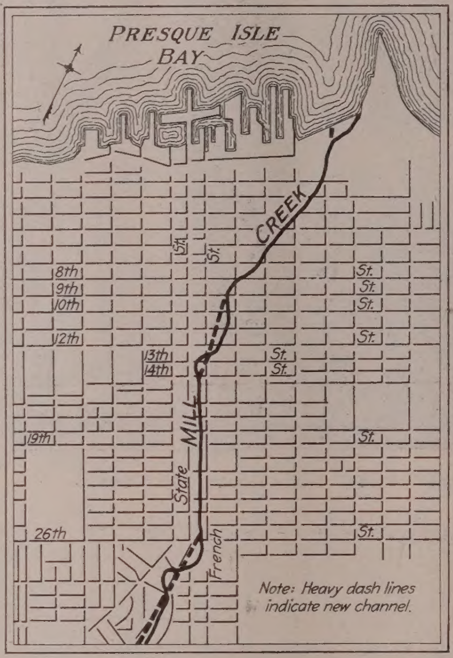
To carry men and light loads quickly to the top of the bridge while the main travelers are working out over the river, two elevators, one of which is shown in an accompanying photograph, are used. They are handled on two parts of wire rope by the backstay travelers, and are tagged by a small block at one side of the car which runs on a wire-rope guide. These guides, stretched from the top laterals to dead men in the ground, are purposely out of plumb. This causes the cars to hang on the under sides of the guides, and prevents twisting.

The Hell Gate bridge was designed and is being erected under the direction of Gustav Lindenthal, chief engineer, and O. H. Ammann, assistant chief engineer of the New York Connecting Railroad. H. W. Hudson, construction engineer, has immediate supervision of the erection. The contractor for the fabrication and erection of the arch is the American Bridge Company, for which C. G. Emil Larsson, assistant chief engineer, is in general charge of the work, and J. B. Gemberling, erection manager, is in charge of erection. J. Loewenstein, H. H. Starr and W. J. Parsons, engineers for the American Bridge Company, are connected with the work, and Daniel Burns is general foreman in direct charge of erection.

Erie Can Remove Flood Menace by Spending $798,000 on Mill Creek Improvement

Farley Gannett, in Report to City Engineer, Recommends Channel Rectification, Closed and Open Sections of Conduit and Dry Reservoir for Stream Control

To prevent a repetition of the disastrous flood which swept through Erie, Pa., last August, a project involving the expenditure of $798,000 for the rectification of the alignment of Mill Creek, the substitution of a closed concrete conduit and an open, concrete-lined channel for the present stream bed and the construction of a dry detention reservoir to impound extraordinary flood flows and control the stream flow, has been proposed by Farley Gannett, consulting engineer, of Harrisburg, in a report submitted Sept. 25 to Benjamin E. Briggs, city engineer of Erie. Of the several possible methods of stream treatment considered Mr. Gannett recommends that the following one be adopted on the grounds of effectiveness and economy:



Note: Heavy dash lines indicate new channel.

NEW PLANS REMOVE SHARP BENDS IN MILL CREEK CHANNEL

PROPOSED PLAN

The closed, reinforced concrete conduit proposed extends from the lake front at the Pennsylvania Railroad crossing to the Nickel Plate railroad crossing, approximately 8100 ft., eliminating all sharp bends and relocating about 2400 ft. of the channel to obtain a shorter and straighter course. It will be 18 ft. wide by 14 ft. high, and will have a capacity of 6000 sec.-ft. From the Nickel Plate crossing to the city line the creek will be carried in an open, concrete-lined channel, 4800 ft. long, 25 ft. wide on top and 12 ft. deep, with the same carrying capacity as the closed conduit. A dry reservoir at the forks in the creek, 1¼ miles above the city line, having a capacity of 52,000,000 cu. ft. is recommended. This reservoir would ordinarily be empty, as it would be drained by a culvert large enough to pass all but exceptional floods. The plans would effectively prevent floods in Mill Creek, Mr. Gannett states, and the cost would be far less than the damage done by the flood of Aug. 3, which was described in detail, with records of rainfall and runoff, in the Engineering Record of Aug. 14, page 186.

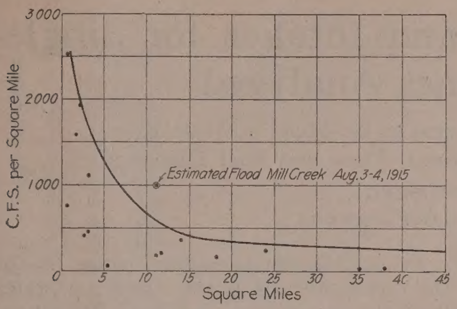
DESCRIPTION OF MILL CREEK

Mill Creek is a small, swift stream flowing into Presque Isle Bay, Lake Erie, through the eastern part of the city of Erie, draining at its mouth 12.9 sq. miles. Of this area, 2.0 sq. miles lie within the city limits and are largely built over. The watershed lies in the sandy, gravelly soil typical of this once glaciated region, and is underlaid by a gray slate formation, which is productive of a high rate of runoff, particularly when the gravel subsurface soil is saturated.

The uplands are in a high state of agricultural productivity, while the lower valleys are deep and bordered with steep hills. The countryside is composed of rolling hills, with small patches of timber. The only village on the watershed is Belle Valley, composed of a small group of houses. Just before entering the city limits the stream emerges from a narrow valley, through which it passes for about 2 miles. The sides of this part of the valley rise sharply about 100 ft. above the water.

The sources of Mill Creek are at an elevation of 1100 to 1300 ft. above sea level, or 500 to 730 ft. above Lake Erie. Above the city for two miles the fall of the creek is

THIS IS THE SORT OF DAMAGE WHICH THE ERIE FLOOD PREVENTION PLANS, IF ADOPTED, WILL RENDER IMPOSSIBLE

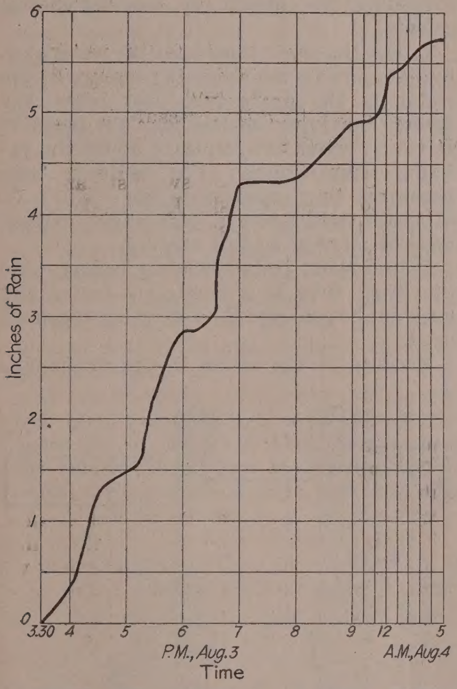


MAXIMUM RECORDED RATES OF RUNOFF FOR PENNSYLVANIA STREAMS

1.04 ft. per 100 ft. At the southern boundary of the city the creek is at an elevation of 170 ft. above the lake. The fall per 100 ft. through the city is 1.20 ft., being 20 per cent steeper than in the section above.

AUGUST FLOOD

The total rain for the storm at Erie was 5.77 in., between 3.30 p. m., Aug. 3, and 5 a. m., Aug. 4. The rain in the hills above the city was about 40 per cent greater than at Erie, and such in fact must have been the case to have caused the extraordinary rate of flow that occurred. The evidence is that the rain was largely confined, on the upper watershed, to the period from 5 to 8.30 p. m. The comparatively short time within which it fell is the reason for the great flood which resulted.



ACCUMULATED RAINFALL AT ERIE DURING THE STORM OF AUG. 3-4, 1915

At Twenty-sixth Street the rate of flow per square mile from the 11 sq. miles above that point was about 1000 cu. ft. per second per square mile. This figure has often been exceeded from smaller areas but seldom from so large a watershed, according to Mr. Gannett. The extraordinary volume of this flow of 11,000 sec.-ft. may be best appreciated when one realizes that it is about nine times the extreme dry weather flow of the Ohio River below Pittsburgh, which drains 23,000 sq. miles, against 11.1 sq. miles drained by Mill Creek above Twenty-sixth Street, in Erie.

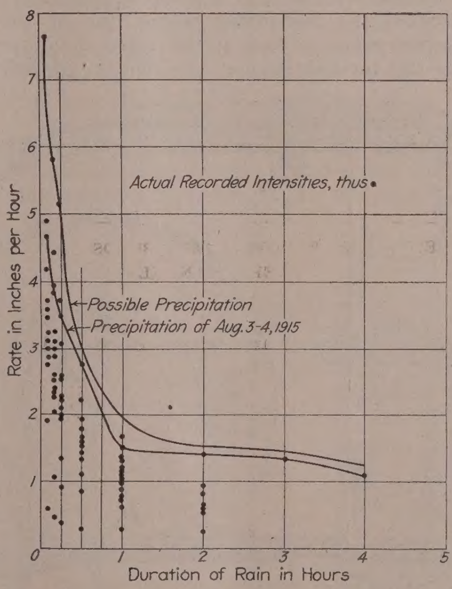
One of the most destructive features of the flood was the vast amount of débris, consisting of trees, brush, lumber, parts of houses and barns, and all manner of furniture and personal property, including carriages, wagons and automobiles, which was washed into the channel and clogged the bridge and culvert openings over the creek. In the city limits not one of the twenty-one street crossings and three railroad culverts carried the flood. When they were overtopped, either the bridge or the culvert, or the approach fill was destroyed. In most cases the culverts stood and the fills failed by overtopping.

CHANNEL ENCROACHMENTS

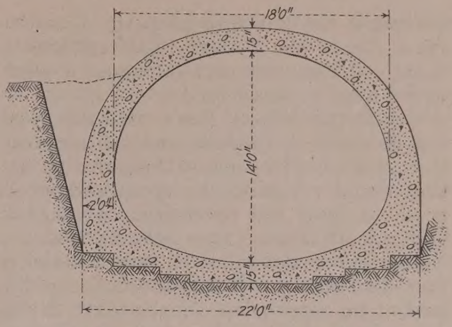
The course of the stream through the city is extremely tortuous; there are two bends of approximately 90 deg. and numerous other sharp turns. Portions are walled in on one or both sides with concrete or stone walls. Buildings abut on and encroach upon the channel. The creek bed has long been used for dumping all manner of débris. Houses, mills, stores and factories have been built on the waterway, reducing its channel area far below safe proportions. All of these things contributed to reducing the channel area and to lessening its capabilities of discharging a large volume.

IMPROVEMENTS RECOMMENDED

Wherever possible the present alignment would be followed in Mr. Gannett's plan, but, as it is most essential that all bends be eliminated and that the route be made as short as possible, certain changes in alignment are desirable, as shown by the dash line on the accompanying map. The greatest divergence of the revised alignment from the present channel would be from Tenth to Twelfth Street, where they are approximately 200 ft. apart. The new line traverses a section in which few buildings stand and in which all were either removed or badly damaged by the flood of Aug. 3. From Fourteenth Street to Twenty-sixth Street the old channel is closely followed. At Twenty-sixth Street the new line swings on an easy curve to the west of the present creek, crossing it at Hill Road and Moorhead Street, eliminating two sharp bends and 1000 ft. of length, terminating to the west of the old line near the city limits. The improved channel would terminate in an intake, with wing-walls and dikes designed to throw the water into the concrete channel. Between the intake and the reservoir it is proposed to remove dead trees, logs and débris and to improve the existing channel in some places.



PRECIPITATION INTENSITIES AT ERIE SINCE THE YEAR 1900



PROPOSED CLOSED CONDUIT SECTION

DRY DETENTION RESERVOIR

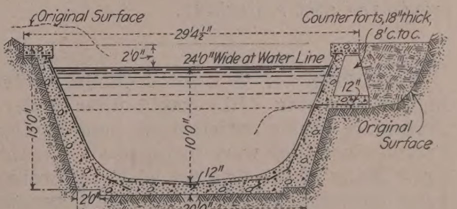
Where the side hills converge 1¼ miles above the city line, a dry detention reservoir is proposed. This reservoir, formed by a massive concrete barrier, 60 ft. high, with an opening in its base 7.5 ft. in diameter, would have a capacity of 52,000,000 cu. ft. or 390,000,000 gal. This structure would be 350 ft. long on top and approximately 40 ft. thick at the base. The reservoir would be 1 mile long, but the land inundated would be of small value, as most of the 55 acres is stony lowland or steep valley side.

The reservoir would seldom have any water in it, as only at long intervals would a flood come down the creek larger than would be carried by the culvert which would drain it. But at the rare intervals when such a flood did come the reservoir area would be there to absorb it, letting out just so much water as could be safely carried down through the city. The conduit is so designed as to be capable of carrying the water let through the reservoir plus the maximum runoff from the area north of the reservoir which would enter the creek. The reservoir would catch débris from the 8.5 sq. miles above it and so prevent its getting into the channel. A drift, or débris catcher or deflector, could also be constructed at the upper end of the concrete channel.

The economic advantage of the reservoir scheme lies in the fact that, through its construction, the channel through the city can be made much smaller at a large saving in cost. Some day the channel between the city line and the reservoir will have to be improved and this work would also be cheaper if there were a reservoir.

REASONS FOR CHANNEL SECTIONS

The open, sloping-sided channel above the Nickel Plate railroad crossing is recommended for several reasons. The land is not so valuable as below. The sloping-sided channel is cheaper than the closed conduit and there is little immediate need of covering this portion of it. If the city



PROPOSED OPEN CHANNEL SECTION

purchases the abutting property along the creek, from the Nickel Plate railroad to Glenwood Park, for park purposes, it would never need to be covered.

Below the Nickel Plate railroad crossing the land is valuable and the construction of a covered conduit through this section would result in the reclaiming of 12 acres of land for residential, commercial and industrial use. It is believed that this would represent a value of several hundred thousand dollars. About 150 acres in this part of the city, below Twenty-sixth Street, was depreciated and damaged by the flood of Aug. 3. With the creek inclosed and no longer a potential danger, and with this land utilized by buildings, it is computed that the increased taxes would more than pay the interest and sinking fund charges for this work. After completion of the conduit, property owners will rapidly refill the area over it to street grades and utilize it. At least, such has been the experience in other places.

At Twenty-sixth Street a high concrete arch bridge is proposed, spanning the entire valley with one or two arches.

The estimate includes reconnecting all broken sewers with the interceptor in the lower portion of the city, and siphoning under the conduit at all sewer crossings. It also includes refilling all street crossings and repaving streets at creek and conduit crossings and replacing curbs and sidewalks. It also includes cleaning up the remaining débris and leaving the entire area in a suitable condition.

Manholes at street crossings would give access to the conduit for inspection and cleaning, although the high velocity, 20 miles per hour during extreme floods, would keep it clean. The grade has been determined so that the top of the conduit and top of the walls of the open section will be below street grades.

The work can be done well within the cost of $798,000, Mr. Gannett states, if contracts can be let this fall or early next winter, but as prices for labor and materials are rising, delay beyond that time will probably increase the cost materially.

HOLDING-DOWN BOLTS of Monel metal in the Evanston (Ill.) rapid filter underdrains are giving satisfaction, none having broken since they were installed six months ago. Many of the first set of ¼-in. bronze bolts and the second set of ⅜-in. bronze bolts gave a great deal of trouble from breaking.

Design of Scroll Cases and Intakes for Single-Runner Turbines Analyzed

Part II—Location of Case, Allowances to Be Made in Calculations and Desirable Shape of Cross-Sections, Floor and Roof Discussed

By A. G. HILLBERG
Hydraulic Engineer, New York City

THE VERTICAL sections of a scroll case should as far as possible be symmetrical about the horizontal center line of the distributor. Consequently, this center line must be known before the scroll case can be given its shape. In determining the location of the horizontal center line of a distributor, which is a plane in which are located the horizontal center line of the wheel gates as well as the rated diameter of the turbine runner, the velocity of flow in the upper part of the draft tube must be known. This velocity can be determined by the formula $v = c\sqrt{2gh}$, where c is a constant depending upon the design of the runner. For larger low-head units c varies from 0.3 to 0.4. The turbine builder must be requested to give either this constant or the velocity of flow directly. Should the designer of the power-house substructure require a value of c to enable him to locate approximately the center line of the unit, before the design of the turbine has been determined definitely, it is better to assume too high than too low a value.

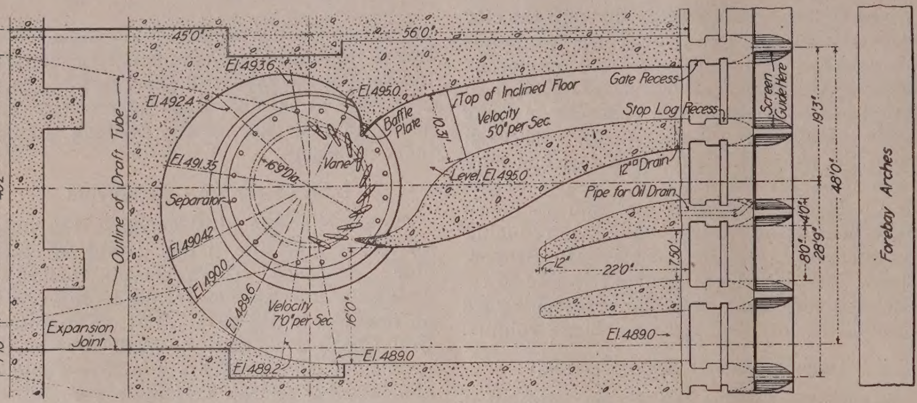


FIG. 5—WELL-DESIGNED SCROLL CASE—ONE-FOURTH OF DISCHARGE FED DIRECTLY TO WHEEL IN ORDER TO DECREASE OVER-ALL WIDTH OF UNIT—IN THIS CASE $\alpha = 315$ DEG.

Criticism.—Fillets are too small, which permits dead water, thus decreasing effective area of section.

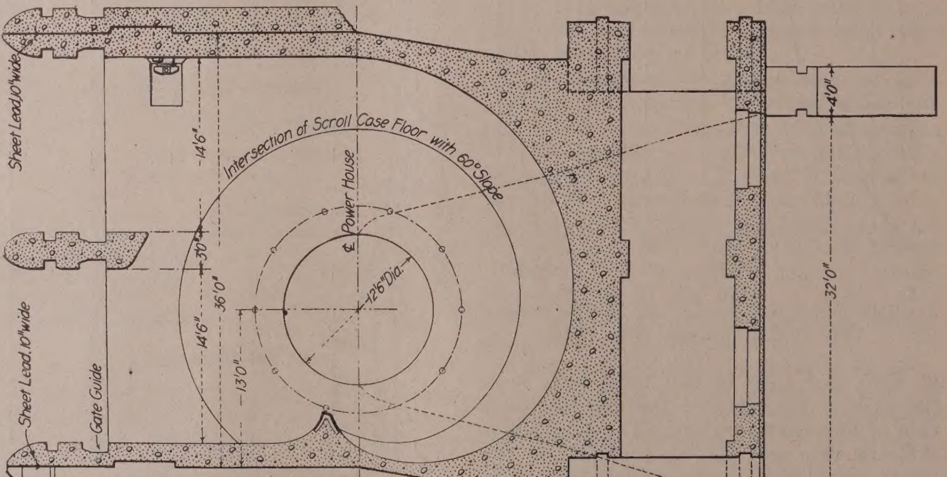


FIG. 6—POORLY DESIGNED SCROLL CASE—INTAKE TOO SHORT—PIER NOSE TOO BLUNT—$\alpha = 340$ DEG.—POSSIBILITY OF AN EDDY BECAUSE OF SHARPNESS OF CURVE CONNECTING MASONRY WITH SCROLL NOSE

In locating the horizontal center line of the distributor above the lowest tail-water level the determining factor is the atmospheric pressure, which at the sea level and 62 deg. Fahr. equals a column of water 33.9 ft. in height. The height of this column decreases with the increase in altitude. The total draft head, however, that is, the static head plus the velocity head, must be made less than the theoretic barometric column for the elevation under consideration, because a margin should be allowed:

1. For governing purposes, as a sudden closing of the turbine gates tends to increase the vacuum immediately below the runner, and a margin must be available in order to prevent the total draft head from exceeding the height of the barometric column.

2. For the vapor tension of the water—or, in other words, the absolute pressure of the water in the draft tube just below the runner should not be less than the pressure at which water will vaporize under the existing temperatures. For ordinary temperatures this pressure is less than 1 ft. of water, and hence a very slight margin need be allowed on this account.

In the usual installation air leakage into the draft tube is a negligible factor and need not be considered as affecting the draft head.

Because of the losses in the draft tube due to friction and curvature and the outflow loss from the draft tube, all of which tend to decrease the total actual draft head, it is possible to increase the distance of the turbine above tail water.

It is customary to measure the static head to the top of the runner band, or the bottom of the distributor, which is the same thing. The velocity inside the band of the runner at this point is calculated, so that a maximum value of the total draft head is obtained. It may be argued that the vacuum does not extend into the runner as high as to the bottom of the distributor,

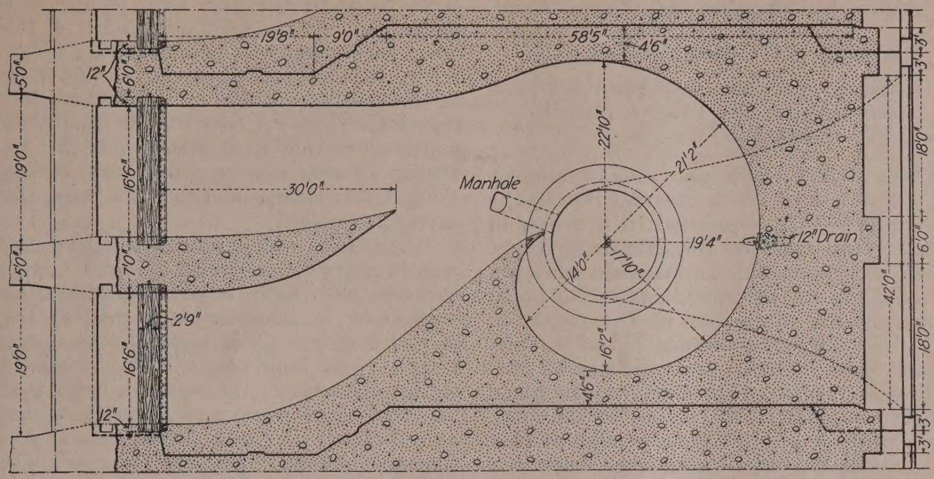


FIG. 7—EXCELLENTLY DESIGNED SCROLL CASE AND INTAKE—$\alpha = 260$ DEG.—NOTE SMOOTHNESS OF CURVATURE AND THINNESS OF PIER NOSE

which is true of that part of the runner adjacent to the band. At the center, however, it does extend that far, and in some wheels even a little farther, because the water at the center of the runner has already been discharged from the runner passages at that elevation. Consequently, if the vacuum is too high, there is danger of erosion at the center, if not elsewhere.

Applying Bernouilli's theorem to this case, the equation

$$D = E + (v^2/2g) - L$$

can be established, where D = total draft head at the runner; E, difference in elevation between top runner band and lowest tail-water level; v, velocity of flow through band of runner at full load; g, 32.16; and L, all losses due to friction and curvature in draft tube and outflow loss at end of draft tube.

It can be readily seen from this formula that for a given value of D the greater the losses are in the draft tube, the greater is the value of E. Thus, in determining the value of E for a given plant, a margin must be allowed between the total draft head at the runner D, and the height of the barometric column, in order to allow for governing and vapor tension, as mentioned above.

If, therefore, E is solved for in the formula and D is given the value $33.9 - M$, where M is the margin allowed for governing and vapor tension, the formula becomes

$$E = 33.9 - (M - L) - (v^2/2g)$$

In this equation all quantities are known except E and $(M - L)$. It is usual to assume the value of $(M - L)$ to be from 3 to 6 ft., depending upon the physical conditions of the plant in question. Should the draft tube be excessively long, therefore, and the expected load variations severe, it is advisable to assume the higher value of 6 ft. In the case, however, of a plant with a normal-length draft tube, where the load conditions ordinarily would be steady, the minimum value of 3 ft. could be used.

Conservative engineers have, in the design of very large draft tubes, where the conditions were favorable and v was 18 ft. per second, used 8.9 ft. as the value of $(M - L)$, thus making E 20 ft. It must be borne in mind, however, that such a procedure is not always advantageous, as one of the advantages of single-runner units is that the runner can be placed high enough to make it accessible for inspection at average stages of the tail water, without requiring cofferdamming the draft-tube opening, and pumping out the water.

The horizontal center lines of the cross-sectional areas of the scroll case should be located in the same plane as the center line of the runner. It is, however, not always possible to do this, for reasons that will be given later.

SHAPE OF SECTIONS

Theoretically the best shape of the cross-sections of a scroll case is circular, as the hydraulic radius is then a maximum and the difference between the maximum and minimum velocities of the flow in the section a minimum. Economic reasons, however, prevent the use of such a shape, as the width of the unit, and, consequently, the amount of concrete needed in the substructure would be unduly large. In order to reduce the over-all width of the scroll case as much as possible the cross-sectional areas are usually flattened in such a way that their longest dimension is vertical.

To facilitate the form work it is customary to make the far side of the scroll case, that is, its periphery, vertical. The floor and the roof may be horizontal, but as sharp corners will create "dead" water, thus reducing the sections, large fillets must be provided. These fillets are sometimes so large that they meet in the center, thus making the roof and the floor arcs of circles in the transverse sectional elevation.

The upper and lower foundation rings of the speed ring usually have curves conforming with the arcs of circles. In that way an efficient bell mouth is created. To increase the effect of this bell mouth the scroll case is connected by sloping sides to this speed ring. These sides have a slope

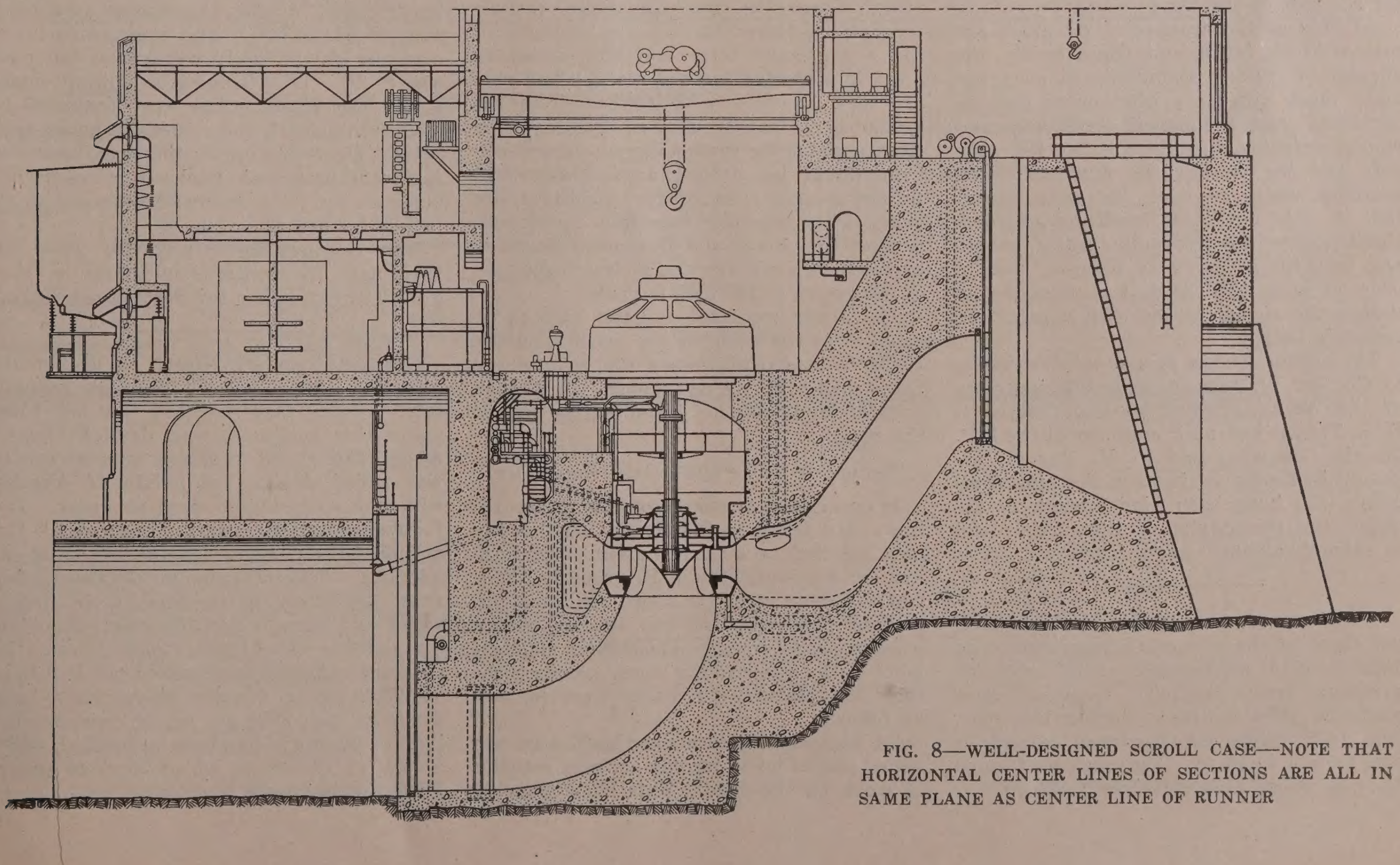


FIG. 8—WELL-DESIGNED SCROLL CASE—NOTE THAT HORIZONTAL CENTER LINES OF SECTIONS ARE ALL IN SAME PLANE AS CENTER LINE OF RUNNER

of from 45 to 60 deg. with the horizontal. The effective area of the scroll case sections, however, are to be figured up to the outer edge of the speed-ring vanes. Typical scroll-case sections are shown in the accompanying drawings, Figs. 5 to 8.

As previously stated, the most advantageous location of the scroll case is when its horizontal center line conforms with the horizontal center line of the runner. Generally such a location will place the scroll case rather high, thus requiring more concrete in the substructure than with the center line at a lower elevation. This may lead the reader to believe that the lower the center line of the scroll case, the more economical will be the substructure, but there is a limiting feature which cannot be disregarded without serious effect. The draft tube curves in a downstream direction, and the designer must provide enough masonry between it and the scroll case to prevent the water from breaking through or even percolating through the masonry at the thinnest point. The critical section is generally that located on the transverse center line of the unit, or, more exactly, that located in a vertical plane laid through the axis of the draft tube.

FLOOR AND ROOF

The floor and roof of a scroll case can be parallel to each other until such a point has been reached that it is necessary to slope them toward each other in order to reduce the cross-sectional areas of the scroll; they can be given a uniform slope from the beginning to the end of the scroll, or the roof can be kept horizontal while the floor is given an upward slope. For very large and deep scroll cases placed so that the horizontal center line is considerably lower than the horizontal center line of the runner, this latter arrangement is advantageous, as it brings the center line of the scroll higher and higher. As soon as a point is reached where both lines are in the same plane, the roof should also be given a slope, so that this condition is maintained for the rest of the way.

As long as the cross-sectional areas are comparatively large, and, consequently, the amount of water abundant, it does not make much difference whether or not the horizontal center lines of scroll case and runner coincide, but the smaller the area gets and the smaller the amount of the available water becomes, the more important it is to have this condition satisfied. Furthermore the hydraulic radius should also be kept as large as possible, and in order to accomplish that it is necessary to design the smaller areas with a rapid decrease in height.

The author wishes to express his thanks to Chester W. Larner, hydraulic engineer of the Wellman-Seaver-Morgan Company; H. B. Taylor, hydraulic engineer of the I. P. Morris Company, and F. H. Rogers, assistant hydraulic engineer of the same company, who have been kind enough to examine the manuscript of this article and to submit valuable suggestions.

HYDRANTS MANUFACTURED in the municipal shops of the city of Chicago numbered 1832 in 1914, an increase of 457 over the previous year's output. Repairs were made on 1054 hydrants during the year. The 1448 valves manufactured ranged in size from 4 to 16 in. The work performed in these shops aggregated $421,525.80.

Colorado Makes 50 Per Cent Saving with Convict Labor

J. E. Maloney, State Highway Engineer, in Discussion, Describes How Criminal Labor Is Organized for Road Work

CONVICT LABOR used on 140 miles of State road work in Colorado during the years 1913-14 has resulted in a saving in cost to the State of approximately 50 per cent, according to J. E. Maloney, secretary engineer of the Colorado Highway Commission, in his discussion of the paper on "Convict Labor," presented by G. P. Coleman, State highway commissioner of Virginia, on Sept. 16, before the Pan-American Road Congress. Forty miles of the work was through a rough mountainous country and about 100 miles through the more level plains section.

According to Mr. Maloney convict labor is especially adapted to rough, sidehill work, where but few teams are required, and where a large number of men can be used to advantage after the grade line is established and the work opened up.

CONVICT CAMP ORGANIZATION

The camp is placed in charge of a superintendent, who is assisted by one or more foremen. These men are all the salaried officials connected with the camp. Anywhere from 25 to 75 prisoners are detailed to a camp. The selection of the men who are placed in charge of the camp is in the hands of the penitentiary officials. The salary of the superintendent runs from $100 to $125 per month, and for the assistants the salary runs from $60 to $75 per month. In addition to salary, board is furnished.

In all the camps in the State the equipment is paid for from the county and State road fund. This equipment consists of wall tents of extra heavy canvas, with flies, and in the winter the walls of the tents are boarded and papered and heating stoves provided. The men sleep in separate bunks, from four to eight in a tent. Then there are the superintendent's quarters, the assistants' quarters, the cook and dining tent, the commissary tent, and the necessary tents and shelter for the stock. The men are well provided with clothes from the penitentiary, but are not in stripes, being clothed about the same as an average workman would be clothed around any contractor's camp. The sanitary conditions are looked after carefully, especially the cleanliness of the camps and the men. Sanitary precautions are taken and a close inspection of the health of the men is made.

The stock necessary for the hauling of supplies to the camp or for work upon the roads is also paid for by the county and State road fund. A camp outfit for 35 men costs about $2,500, not including the cost of the stock.

CHOICE OF CAMP OFFICIALS IMPORTANT

In organizing a convict road camp, according to Mr. Maloney, it is important that the men selected as superintendents and foremen or overseers should be properly qualified for their place, as these are most important positions, and the success of the work depends entirely upon their management of the men and the work. Along these lines Mr. Maloney's remarks were in part as follows:

"A comparative idea may be had by the actual cost of labor per day per man actually at work on the road. This runs from 77 cents to $1.50 per day, and, having this figure, compare the relative efficiency of the labor as between the prisoner and the ordinary road laborer. It is believed this work of the prisoners will show an average saving of about 25 per cent for the conditions under which they have been worked in this State. In some cases a much larger saving than this is shown, and in other cases the saving is smaller.

"In addition to carefully selecting the men in charge of the work, it would be wise to have the State Highway Commission authorized to take entire charge of the direction of the work, especially as to the locality to be improved, and also in regard to the character of the work, in order that the improvements may be along some connected system of roads, rather than at disconnected points all over the State, and also in order that the work may be uniform and along standard lines."

TYPICAL COSTS FROM TWO CAMPS

In one camp run from October, 1912, to July 1, 1913, the total cost was $6,284.74, equipment not included. The total number of days worked was 248. The average cost of food per man per day was 31.5 cents; the average cost per man per day was 61.5 cents; this includes all salaries, repairs, stock feed, etc., and the average cost per man per day actually worked on the roads was 77 cents. The average number of men in camp for this time was 40, about eight of these being used about the camp. The average number of head of stock, 8; average cost per mile of road built, $2,513.89. The men in this camp completed 2½ miles of 16-ft. road, all mountain sidehill work.

In another camp for the season of 1914, or from Aug. 1, 1913, to Sept. 1, 1914, the total number of days worked was 296½. The average number of men, 33; the average number of head of stock, 6; the average cost per man per day for food, 37.6 cents, and the average total cost per man per day was 89.15 cents; the average cost per miles was $3,163.60, and a length of 3.67 miles was finished during the season at a total cost of $11,613.96. The average cost per man per day actually worked on the road was $1.50. This included a drilling outfit, which cost $2,000. The work consisted of mountain sidehill and extremely heavy rock cut for about 1¼ miles; the remainder was earth and loose rock, moderately heavy timber clearing. The roadway averaged 16 ft. in width.

The Engineering Record for June 12, 1915, page 751, contains an article on "Virginia Convict Labor for State Road Work."

CONSTRUCTION BY NIGHT on the breakwater at Victoria, B. C., has been necessitated by the fact that but few low tides accur this season during daylight hours. About 150 ft. of concrete superstructure was added during the month of August, which was considered good progress. The following statistics were given out by Dominion Government Engineers' office at Victoria: The total amount of core, or fine rock, deposited up to Sept. 1, in breakwater and piers is 249,925 tons; of rubble, or coarse rock, 712,884 tons. From the time the contract was started not less than 66,373 tons of granite blocks have been deposited and 2978 cu. yd. of concrete facing, 18 in. thick, has been completed, while a total of 12,366 cu. yd. of concrete superstructure has been laid.

New Type of Chart Shows Operation of Terminal

Engineers Devise Simple Diagram for Recording and Analyzing Rush-Hour Train Movements at Dearborn Station, Chicago

DIAGRAMS showing the track occupancy and throat movements during the evening rush period at Dearborn Station, Chicago, which is used by eight railroads, have been prepared by the engineers of the Chicago & Western Indiana Railroad. At the bottom of the accompanying diagram the track layout leading into the station is shown. Above this are drawn on cross-section paper heavy horizontal lines numbered and named to correspond to the positions of the various terminal tracks. On the horizontal lines time is plotted, 1 in. being equal to 5 min. The vertical lines are used to indicate the number of cars per train, 1 in. being equal to 10 cars. In the accompanying reduced-scale cut only the 1-in. cross-section lines are shown.

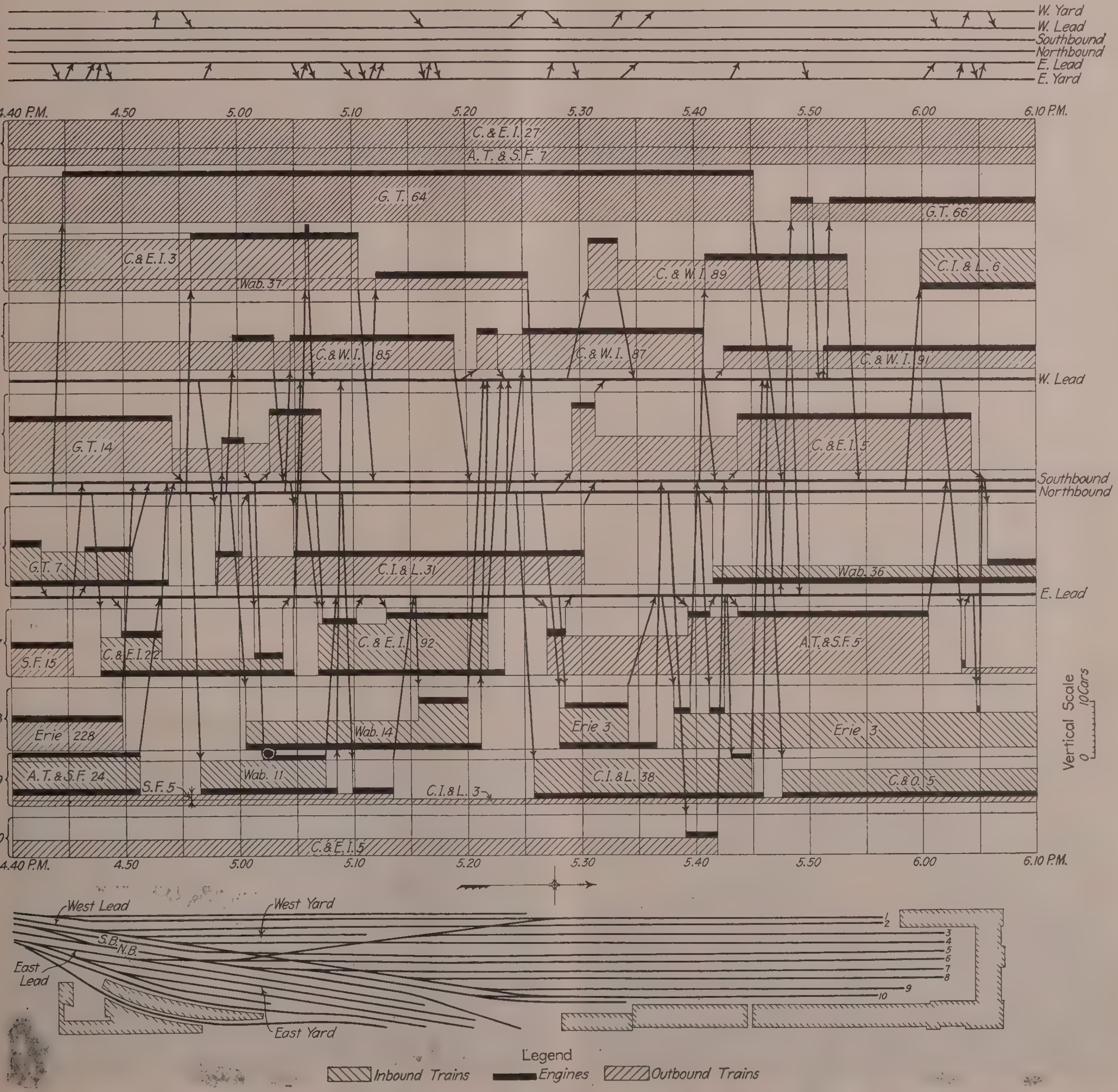
The timetable in effect when the diagram illustrated was made is shown in the accompanying table, although it appears in the upper right-hand corner of the original diagram. In the period of 1½ hr. there were 129 train or engine movements, averaging one every 42 sec.

Arrows are used to show the direction of engine movements. For example, at 5.28 p. m. a light engine comes from the northbound main to track 5 with outbound Chicago & Eastern Illinois train 5 of twelve cars. At 5.32 the engines go to the west lead with five of twelve cars. At 5.43 a road engine comes with three baggage cars and at 6.04 the train pulls out over the southbound main. At 5.30, it may be noticed, every track except No. 3 is occupied, and an outbound train is backing in on it. Track 1 could be emptied if needed, however, as it is only storing evening trains.

EVENING RUSH-HOUR TIMETABLE AT DEARBORN STATION, CHICAGO.

Arrive			Leave		
Railroad	Train No.	Time	Railroad	Train No.	Time
G. T.	7	3.30	A. T. & S. F..	15	4.45
A. T. & S. F..	24	4.30	Erie	228	4.48
C. & E. I.....	22	4.50	G. T.	14	5.00
Wab.	11	4.55	C. & E. I.....	3	5.10
Wab.	14	4.59	C. & W. I....	85	5.18
C. & E. I.....	92	5.05	Wab.	37	5.25
C. I. & L.....	38	5.25	C. I. & L.....	31	5.30
Erie	3	5.30	C. & W. I....	87	5.40
C. & O.......	5	5.47	G. T.	64	5.45
Wab.	36	6.00	C. & W. I....	89	5.53
C. I. & L.....	6	6.02	A. T. & S. F..	5	6.00
C. & W. I....	602	6.05	C. & E. I.....	5	6.04
			Wab.	39	6.20
			C. & W. I....	91	6.22
			G. T.	66	6.25
			C. & E. I.....	27	7.30
			A. T. & S. F..	7	10.20

By the aid of this chart the operating officials can see at a glance what tracks are occupied at all times, and can also follow all train movements across the throat of the terminal blocking other tracks. The method of analysis is believed to have ad-



DOVETAILING OF TRAIN AND ENGINE MOVEMENTS IN DEARBORN TERMINAL, CHICAGO, DURING EVENING RUSH HOUR vantages over any of those investigated by the committee on yards and terminals of the American Railway Engineering Association.

The diagrams and study were made under the direction of E. H. Lee, vice-president and chief engineer, and R. W. Stevens, general superintendent of the Chicago & Western Indiana Railroad.

SANDY SEWER TRENCHES for a 11½-mile system in Rockford, Ill., all required sheeting, but the work was completed in 4 months. Standard sewer pipe ranging in size from 9 to 33 in. was laid. About 17,000 ft. of 9-in. and 12,000 ft. of 10-in. pipe comprised the largest quantities of any one size. Work was started April 31 and by July 31 the job was completed except for a few manholes. Eleven gangs were maintained by the contractors, the J. B. Sheets Company, of Pittsburgh.

New Type of Submersible Lock Gate at Keokuk Operated by Compressed Air

Unusual Depth to Bedrock Led to Adoption of Floating Gate Controlled by Buoyancy Chambers—Gate and Railroad Bridge Combined

By B. H. PARSONS

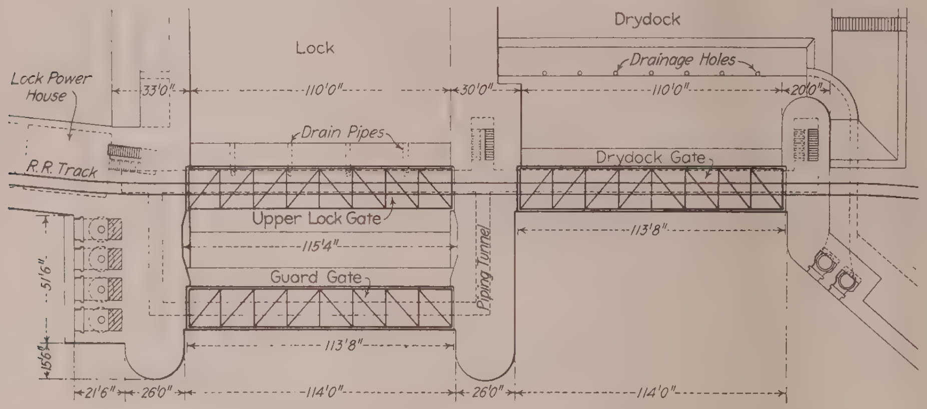
Member, Hugh L. Cooper & Company, Consulting Engineers, and During Construction, Mechanical Engineer of the Mississippi River Power Company

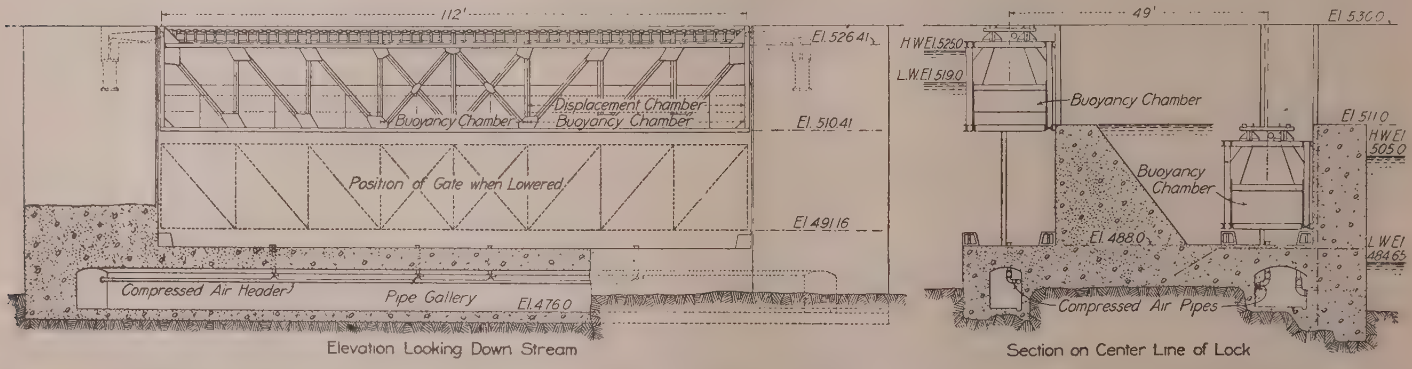
A SUBMERSIBLE lock gate, extending straight across the lock, floating partly out of water when closed and submerged to the level of its sill when open, its movement vertical and controlled by varying the displacement of buoyancy chambers by compressed air—this is a new type and marks a departure in lock-gate design. The writer is not aware of the existence of any similar gate prior to the design and installation at Keokuk.

However simple its form and manipulation, a novelty in such a structure as a lock gate, long established and familiar to all, seems to be cause for interest and speculation. This gate, without machinery, which disappeared beneath the surface, or emerged, frequently covered with fish, excited the curiosity of river folk along the Mississippi and attracted attention generally. New things are invented from time to time, but novelty in engineering structures usually indicates merely the correct adaptation of design to unusual circumstances or conditions of nature.

The lock has been in commission for two years and its operation has not been interrupted during navigation seasons. The gates have, therefore, been thoroughly tested by regular and continuous service. The result is satisfactory in every respect. No lack of compressed air has occurred, nor any shortage in pressure or volume. The power plant operates automatically and requires but little attention. The gates remain, without change or alteration, the same as when first turned over to the Government. After this demonstration of success, the gate is submitted to engineers as a proper solution for the Keokuk lock.

A previous article which appeared in this

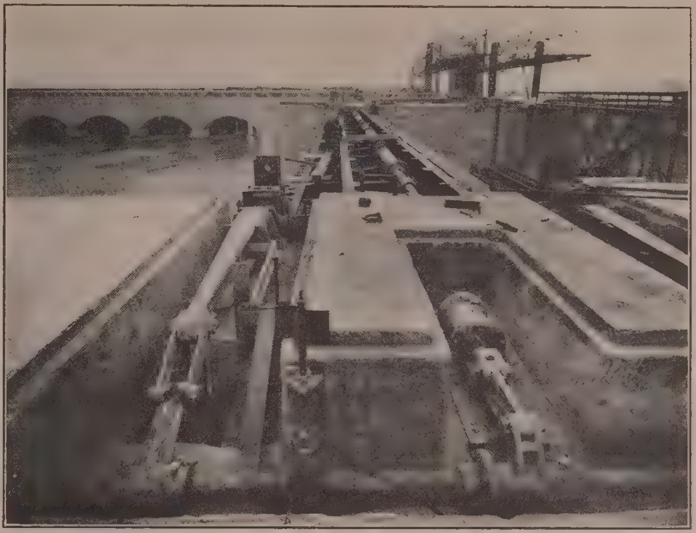




GENERAL PLAN, ELEVATION AND SECTION OF GATES—RAILROAD CARRIED BY UPPER LOCK GATE AND DRYDOCK GATE

TWO VIEWS OF UPPER LOCK GATE AND GUARD GATE—NOTE SMALL LEAKAGE IN RIGHT-HAND PICTURE

UPSTREAM GENERAL VIEW OF ENTRANCE TO LOCK



LATCH OPERATED BY AIR CYLINDER—SEMAPHORE SIGNAL

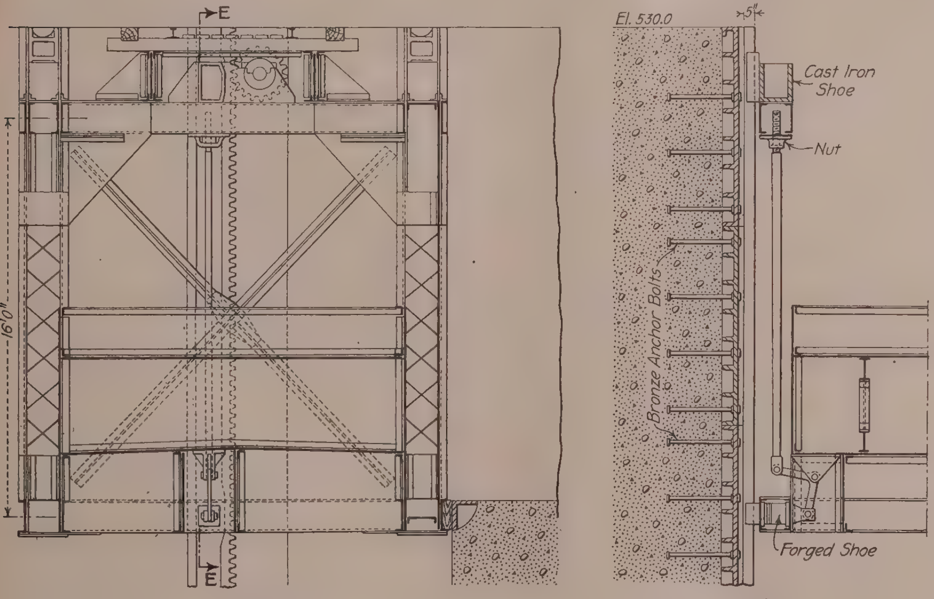
journal (see the Engineering Record of Sept. 18, page 344), in regard to the mitering gate, mentions among other general features of the lock that its width is 110 ft. and that compressed air is its motive power. Some additional data will assist to a better understanding of the present subject.

The bedrock under the river is Keokuk limestone, and was found to be clean swept and exposed throughout the location of the works. Its surface in the vicinity of the upper gates is nearly uniform at El. 480, Memphis datum plane. The water level of the lower pool fluctuates from El. 484.65 to El. 505.00. The established surface level of the upper pool is El. 525.00, and this may be drawn down during extended periods of low water to El. 519.00. The sills of the upper gate, guard gate and adjoining drydock gate are at El. 511.00, and the top of the lock walls is at El. 530.00.

ARGUMENT

It will be noted that the height of the gate sills above bedrock is 31 ft., and that this space is sufficient to allow a gate to descend vertically to the level of its sill without danger of encountering a deposit of silt. There is in fact more than 10 ft. clearance from bedrock to the bottom of the gate when it is in open position. A gate of this kind would not be practicable if it were necessary to excavate a pit in the river bed for its accommodation. The great depth from gate sill to bedrock is a feature of the natural conditions which led to the adoption of this type of gate.

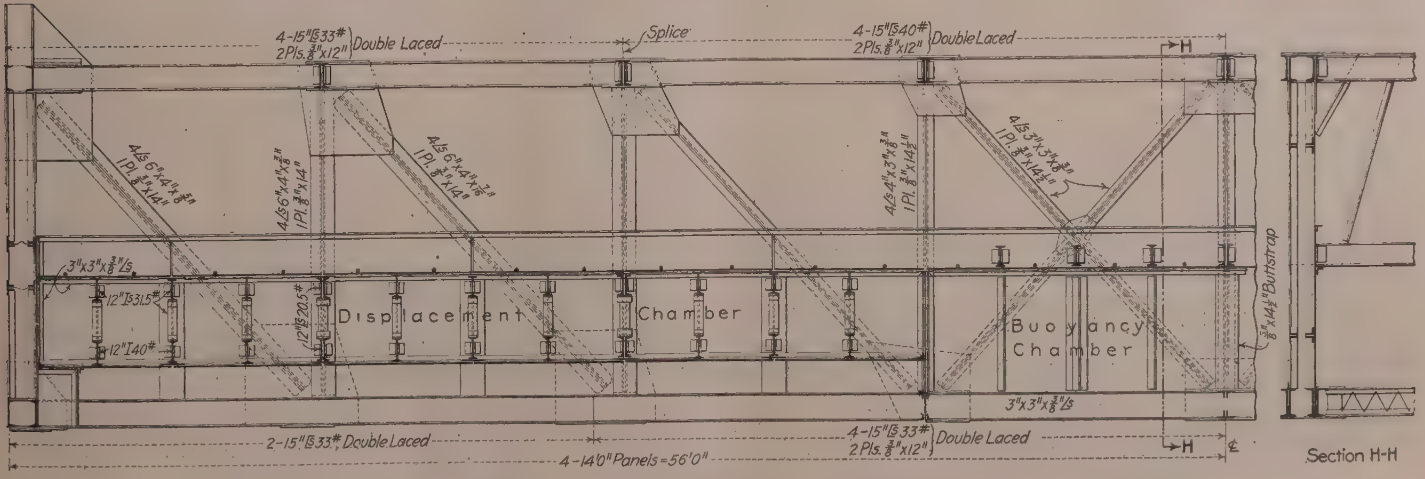
The most convenient railroad to the works is along the Iowa shore, and connecting tracks are laid on the drydock grounds. It was necessary to provide for a railroad track to extend across the drydock and the lock, and thence into the downstream end of the main power house. This track is to serve both the Mississippi River Power Company and the U. S. Government works. Such railroad facility is necessary to the Government works, because the lock power house, the intake and discharge of the culvert system and other machinery and apparatus are on the river side of the lock. The new gate is a bridge as well as a lock gate. If mitering gates had been used,



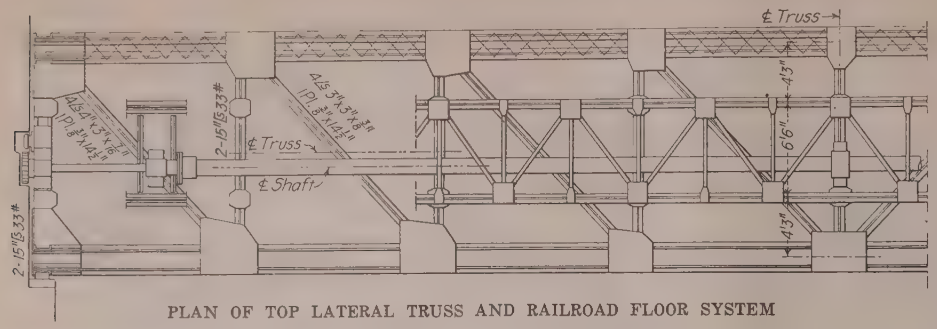
End Section

Section E-E

END SECTION SHOWS RACK AND PINION FOR BALANCING GATE


4-15" [33# 2 Pls. 3/8"x12" Double Laced
Splice
4-15" [40# 2 Pls. 3/8"x12" Double Laced
H
4 Ls 6"x4"x5/8" 1 Pl. 3/8"x14"
4 Ls 6"x4"x3/8" 1 Pl. 3/8"x14"
4 Ls 6"x4"x7/16" 1 Pl. 3/8"x14"
4 Ls 4"x3"x3/8" 1 Pl. 3/8"x14½"
4 Ls 3"x3"x3/8" 1 Pl. 3/8"x14½"
3"x3"x3/8" Ls
12" [31.5#
12" I 40#
12" [20.5#
Displacement Chamber
Buoyancy Chamber
3/8"x14½" Buttstrap
3"x3"x3/8" Ls
2-15" [33# Double Laced
4-15" [33# 2 Pls. 3/8"x12" Double Laced
H
℄
4-14'0" Panels = 56'0"
Section H-H

SECTIONAL ELEVATION THROUGH GATE, SHOWING DISPLACEMENT AND BUOYANCY CHAMBERS



PLAN OF TOP LATERAL TRUSS AND RAILROAD FLOOR SYSTEM

then bascule or other type of lift bridges would have been needed for the railroad track. This circumstance also led to the adoption of the new gate.

Compressed air as the motive power for the lock and drydock had been determined in advance, and the fact that machinery was to be installed for this purpose was additional reason for adopting this gate.

An advantageous feature of these gates is their interchangeability; any one may replace either of the others, and all may be floated out of their recesses by their own buoyancy. Furthermore this type of gate naturally resulted in the building of galleries in masonry under each gate to accommodate the air-supply pipes, etc. These galleries are of value for inspection and communication across the lock. They are inter-connected and have stairways leading to the lock power house and to the top of the lock and drydock walls, and they provide convenient space for the permanent pumping plant for use when it is desired to pump out the lock chamber and culvert system for inspection or other cause.

Attention may also be directed to the economy resulting from the use of this type in place of mitering gates, which is manifested particularly in the decreased length of the lock walls, which are about 55 ft. high.

Finally, it was expected that the new gate, in a single structure, lacking elaborate machinery, and operating by such a safe and dependable power as the displacement of water, would prove to be of the utmost utility, and economical in operation and upkeep.

General Plan of Construction

The accompanying drawings indicate the form and dimensions of the gate, the sizes and arrangement of parts and details of construction. Photographs illustrate the work during its progress.

The upper gate and the drydock gate are opposite to each other, and the guard gate is 49 ft. farther upstream. All three are exactly alike and interchangeable. Each may be raised and floated out of its recess to the drydock for repairs or painting, or to replace either of the other gates, without removing any part, except air connections, and without assistance other than tow lines and barges lashed alongside to prevent its turning turtle.

Each gate consists of two vertical trusses 112 ft. long, center to center of bearings, and 16 ft. deep. The trusses are spaced 15 ft. apart and connected together in the plane of the top chords by a horizontal truss, and in the plane of the bottom chords by lateral bracing—all in the form of a deck railroad bridge, with the usual track stringers and floor system. The downstream truss is, in fact, a plate girder, and its web is heavily reinforced to sustain hydrostatic pressure, thus forming the waterproof skin of the gate. The resulting pressure along the top chord of this girder is sustained and carried to the lock walls by the horizontal truss at the top of the gate. The bottom chord and end frames of the downstream girder are fitted with oak contact blocks, which take bearing upon, and transmit pressure to, the gate sill and the recesses in the lock walls. The gates are eight-panel structures of steel throughout, except as noted.

Displacement Chambers

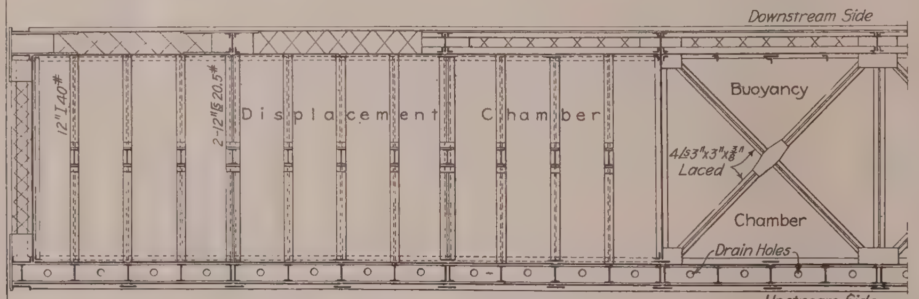
The entire lower part, from a plane 13.21 ft. below the top of the rails and 7 ft. above the lower surface of the bottom chords, is occupied by displacement tanks, arranged as follows: Three panels at each end contain a rectangular box, averaging 4 ft. deep, entirely inclosed and watertight all over. The bottoms of these tanks slope 3 in. toward a small sump at each end of the gate for drainage, and the sumps are connected by heavy pipe of large diameter to equalize any leakage. These tanks contain about 20 tons of ballast, which are needed to balance the gate in all directions, and are provided with manholes, which are accessible when the gate is closed. The combined displacement of these two tanks is 4600 cu. ft.

The remaining 3 ft. of depth below the fixed displacement tanks just described, and the entire depth of 7 ft. in the two central panels of the gate, forms an open-bottomed buoyancy chamber, the displacement of which may be varied at will by admitting air, or allowing it to escape through exhaust pipes provided for the purpose. The maximum displacement of the open-bottomed tank is 5990 cu. ft.

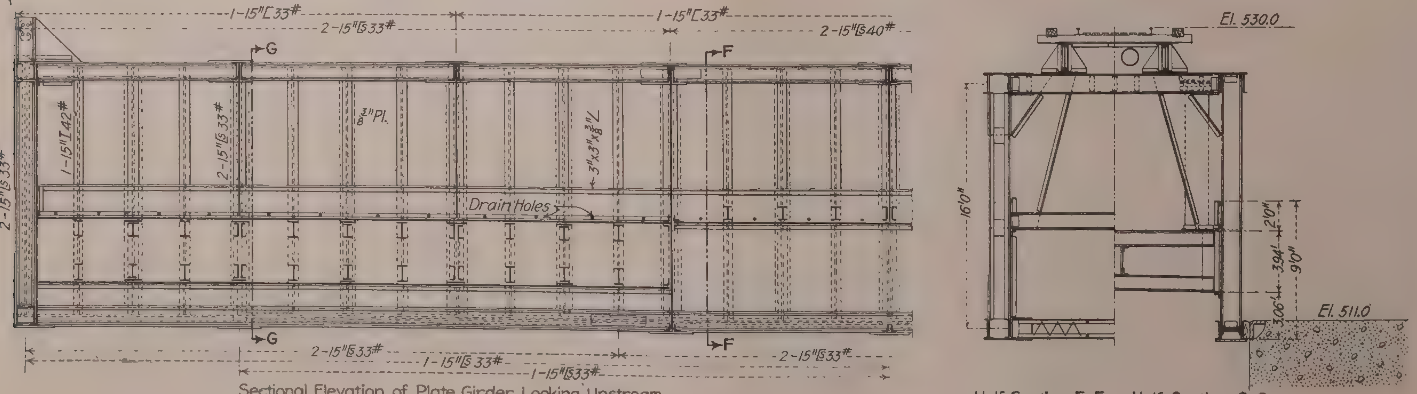
Guides—Sill—Seat

The vertical movement from open to closed position is 19.25 ft., and the gate is confined to position and transverse alignment by guide runners sliding in vertical cast-iron guides bedded in the lock walls at each end. The guides also form toothed racks which engage a spur wheel at each end of the gate, and, as the spur wheels are keyed fast to a heavy shaft which extends from end to end, the simultaneous movement of every part of the gate, and its longitudinal alignment, are assured. The racks, gears and shaft are proportioned to transmit one-eighth of the assumed dead load from either end to the other.

Recesses are formed in the lock walls to receive the ends of the gate, and the downstream faces are continued and connected across the lock below El. 511.00 by the vertical back of a straight transverse wall which forms the gate sill. The downstream face of each recess, and the upstream edge of the transverse wall, which are in one plane normal to the axis of the lock, form the gate seat for closed position, and for



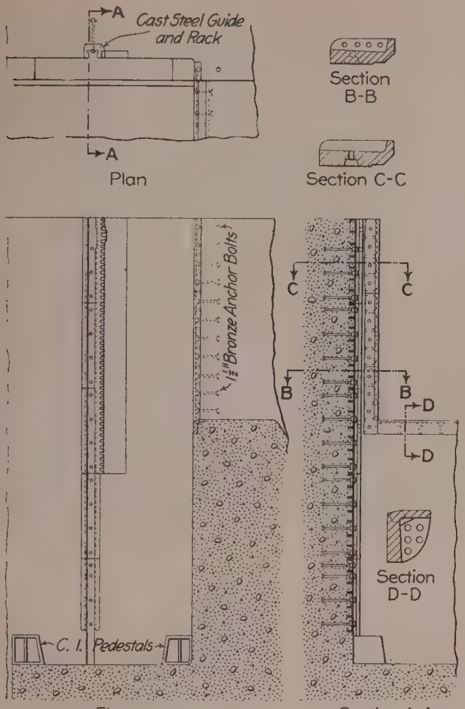
Plan of Lower Chords and Lateral Bracing



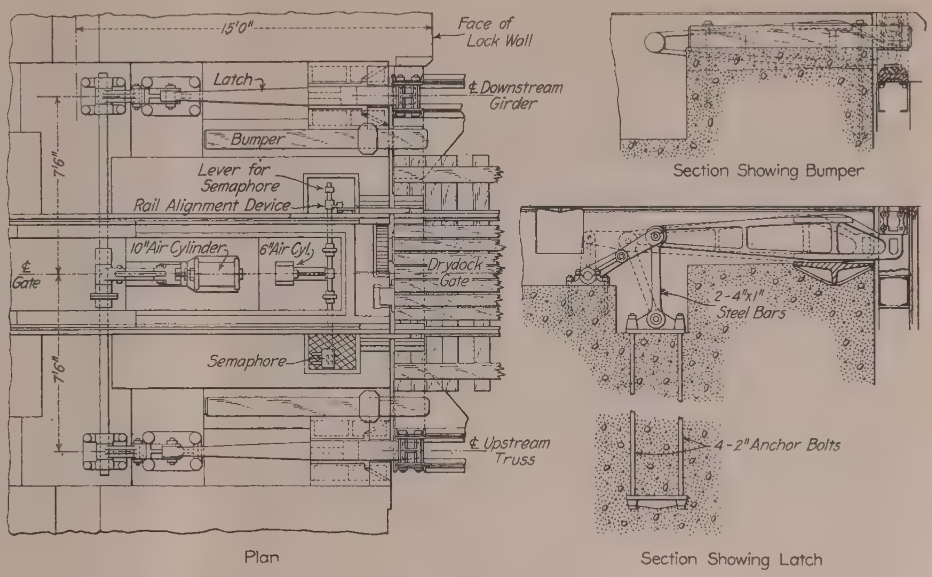
Sectional Elevation of Plate Girder Looking Upstream

Half Section F-F Half Section G-G

LOWER CHORDS AND BRACING IN PLAN VIEW—SECTIONAL ELEVATION THROUGH GATE LOOKING UPSTREAM



DETAILS OF CAST STEEL GUIDE AND RACK



BUMPER, LATCHES OPERATED BY AIR CYLINDERS AND RAIL ALIGNMENT DEVICE

this purpose are fitted with machine-surfaced reaction castings. The anchor bolts for these castings, and for all other similar parts attached to masonry under water, are of bronze.

Water Seal—Support Latches

When the gate is in high position, it becomes a barrier between the upper pool and the lock chamber, for, if water be then drawn from the lock chamber, as in the ordinary course of operation, a head will immediately build up against the gate, and the pressure due to this head forces the gate into contact with its seat. The water seal is thus due to hydrostatic pressure against the gate. The cast-iron guides in which the gate slides vertically are so formed that the gate is withheld from contact with its seat at all times except when in the closed position.

The gate rests on cast-iron pedestals when open, and is locked and supported when closed by heavy cast-steel cantilever beams securely anchored to the lock walls. These beams, or latches, as they are known, are connected in pairs at each end of the gate, and are caused to slide in or out by self-locking toggle connections to a rocker shaft, actuated by an air cylinder. The movement is accompanied by the turning of a semaphore which is in plain view on top of the lock wall at each end of the gate. Bridge joints for the track rails are operated in a similar manner and their movement is likewise indicated by semaphores. The upward movement of the gate is limited by oak bumpers with rubber cushions, which project from the face of the wall. All of this apparatus is located in a pit on top of the walls, and is covered over flush by cast-iron checkered plates.

Loading Used in Design

The downstream girder is proportioned to sustain the hydrostatic pressure due to water at El. 525.00 on the upstream side, with no water pressure acting against the downstream side. The top truss is proportioned to sustain a uniformly distributed load of 2100 lb. per linear foot, which represents the portion of hydrostatic pressure accumulating along the top chord of the downstream girder.

The vertical trusses, acting as a bridge, are proportioned to sustain, first, a dead load of 400,000 lb. uniformly distributed and applied at all panel points, with bridge supported by the latches, or by the displacement tanks; second, a live load consisting of a continuous train of Cooper's E40 locomotives, bridge supported by the latches. The stresses produced by the dead and live loads are such as would result if the structure were supported in air.

The gates were built by the Chicago Bridge & Iron Works, and were erected in place and put into operation by the Mississippi River Power Company. The workmanship is of high order throughout and reflects much credit upon the builders, particularly in respect to the large amount of difficult watertight work involved. Most of the rivets in the web plates of the downstream girder are subjected to direct tension in their shanks by the water pressure. The holes for these rivets were treated by a countersink in a manner to remove the sharp edge under the rivet heads. There is practically no leakage through the gates or their contacts.

Air Supply and Discharge

A pipe gallery or tunnel is located under each of these gates, and a large compressed-air main extends from the lock operator's house through each gallery to serve each gate separately. The air-supply mains are fitted with four discharge branches extend-

GATE ERECTED IN LOWERED POSITION BY TWO-BOOM DERRICK

ANOTHER VIEW OF GATE SHOWS SMALL LEAKAGE

Data Relative to Gate Movement—Variations of Displacement and Air Pressure

Position of gate	Elevation of upper pool	Elevation of top of rails	Weight of gate in air, tons	Displacement of gate, tons	Displacement required in open bottom tank: Tons	Displacement required in open bottom tank: Cu. ft.	Air pressure, lb. per sq. in.
Open	525.00	510.75	231	185.50	45.50	1456	13.59
Top of rails awash	525.00	525.00	231	185.50	45.50	1456	7.40
Top of upper chords awash	525.00	527.96	231	165.75	65.25	2088	6.36
Closed	525.00	530.00	231	159.50	71.50	2288	5.54
Top of tanks awash	525.00	538.21	231	155.25	75.75	2424	2.00

ing up through the roof of the tunnel and terminating in open ends immediately below, and along the center line of, the open-bottom displacement chamber. When compressed air is admitted to the main supply pipe under the gate, it rises freely in open water from each of the four branches, enters the buoyancy chamber and displaces a certain volume of water. Flotation is thus established, and the volume of displacement may be increased up to the full capacity of the tank by this air-supply system.

The open-bottom tank is provided with a pipe of large diameter for the purpose of discharging air. This pipe is fitted to the roof of the tank and is led to one end of the gate and thence up a vertical post of sufficient height to overhang the lock wall when the gate is open. The discharge pipe is then continued vertically upward by a flexible metallic hose to, and around, a large wheel, which is mounted in a housing at sufficient height above the lock wall to accommodate the vertical movement of the gate. The wheel is so constructed, with hollow shaft and stuffing boxes, that the discharge main is continued unbroken past the switchboard. This wheel is counterweighted on one side of its rim and connected to the gate by wire rope on the opposite side, whence its revolution follows the movement of the gate positively without strain on the metallic hose.

Operation and Control

The air supply and discharge systems are controlled at the switchboard, and the volume of displacement may be varied at will, with the result that the gate is raised or lowered as may be desired. The variations in displacement and air pressure, and other data for various positions of the gate are indicated in the accompanying table.

The floor system, containing considerable wood, and the large hollow shaft displace some 632 cu. ft., about 20 tons, within a vertical space of 3 ft. at the top of the gate. When the gate emerges from the surface, this displacement is suddenly released, with the result that the upward movement is arrested, actually stopped, and additional air must be admitted to close the gate. Likewise in descending, this displacement is suddenly thrown upon the gate by the time the rails are awash, and again the movement is effectively stopped.

The displacement of the open bottom tank is elastic, being caused by the air contained, and its volume therefore varies directly with the water pressure under the tank; that is, with the depth of immersion. This displacement is compressed into smaller volume as the gate descends, and would result in acceleration if additional air were not admitted in sufficient quantity, finally, to retard the motion. These conditions are reversed in ascending, when, after the gate has started, air must be discharged to prevent acceleration. In either case the interruption of motion at the surface caused by the large volume of displacement at the top of the gate, is a safeguard of much value over against carelessness or mistakes in the control of the air supply and discharge. Its action is that of an effective brake applied automatically.

Compressed air may be admitted to the fixed volume displacement tanks by a pipe with flexible metallic hose, rigged in the same manner and by the same means as the air discharge. By this means, with pipes leading from the drainage sumps and fitted with suitable check valves, any accumulation of leakage may be expelled. Gages on the switchboard indicate the air pressure in the closed tanks and also in the open-bottom tank.

A system of electric indicators insures safe operation at all times. Electric contacts are made at the limits of motion in the latches and the rail joints, separately for each end of the gate, causing distinctive colored lights to appear or disappear on the switchboard. Similar contacts are made by the large air-discharge wheel throughout its revolution, that is, throughout the vertical movement of the gate, and these contacts always show the position of the gate by suitable lights on the switchboard.

The lock was designed by the writer and was built for the U. S. Government by the Mississippi River Power Company, under the direction of its chief engineer, Hugh L. Cooper. The entire work was conducted under the general supervision of the Corps of Engineers, U. S. Army.

Large Saving in Steel Effected by New System of Flat-Slab Reinforcement

Youth's Companion Building, Boston, a Six-Story Reinforced-Concrete Structure, Contains First Completed Example of New Type of Floor

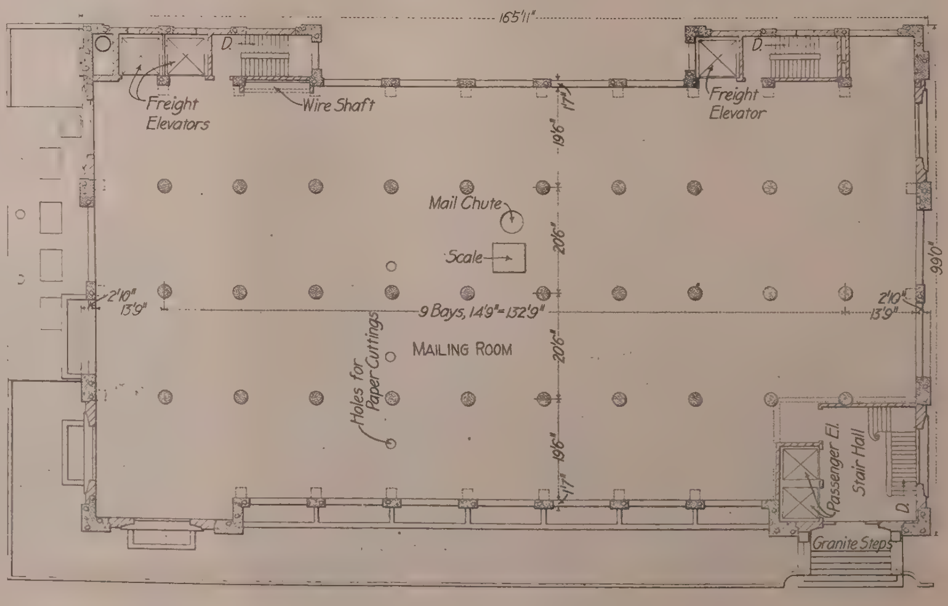
THE RECENTLY completed Youth's Companion Building on Commonwealth Avenue, Allston, Mass., about 3 miles from the State House in Boston, is a six-story reinforced-concrete structure which contains a new type of flat-slab reinforcement which is asserted to effect a saving of from 20 to 40 per cent in the steel required for slab reinforcing as compared with ordinary types. A general description of this building and the details of the reinforcement will be given in this article, and an article on the results of tests of the new slab, including a theoretical discussion, will appear in an early issue.

The building, which will be occupied exclusively by the printing, editorial and business departments of the publishing company, has 165 ft. frontage and is about 100 ft. deep. The columns are spaced as shown on the accompanying plan, the typical floor slabs being 14 ft. 9 in. x 20 ft. 6 in. The story heights vary from 11 ft. 9 in. in the basement to 14 ft. for the first and fifth floors, the other floors having the following heights: Second floor, 13 ft.; third floor, 12 ft.; fourth floor, 13 ft., and sixth floor, 12 ft. 8 in. to the ceiling. A sub-basement extends over about one-third of the building. The exterior finish is concrete with spandrel walls and large steel-sash windows, with a brick and concrete tower at each end, and brick parapets.

Footings and Columns

The foundations are on fine compact sand and all columns have independent footings. The interior column footings are square, 8½ x 8½ ft., and 3 ft. deep, reinforced with two layers of steel, each consisting of seventeen round ¾-in. rods. The wall column footings are 8 x 6 ft. and 2 ft. deep, reinforced with twenty-seven round ⅝-in. rods in the shorter direction and eighteen round ⅝-in. rods in the longer direction.

The interior columns are round, 26 in. in diameter in the basement and 22 in. for



GENERAL PLAN AT FIRST FLOOR OF YOUTH'S COMPANION BUILDING

ASSEMBLING OF STEEL REINFORCEMENT BY UNITS

WALL UNIT IN RELATION TO COLUMN REINFORCEMENT

the remainder of their length. Ornamental column heads at each floor are 6 ft. in diameter. In order to carry the heavy loads in the lower stories the columns in the basement, first and second stories were made of a richer mix, 1:1:2 proportions, with spiral reinforcement. Above these stories longitudinal reinforcement and 1:2:4 mix were used, with ⅜-in. ties 1 ft. apart.

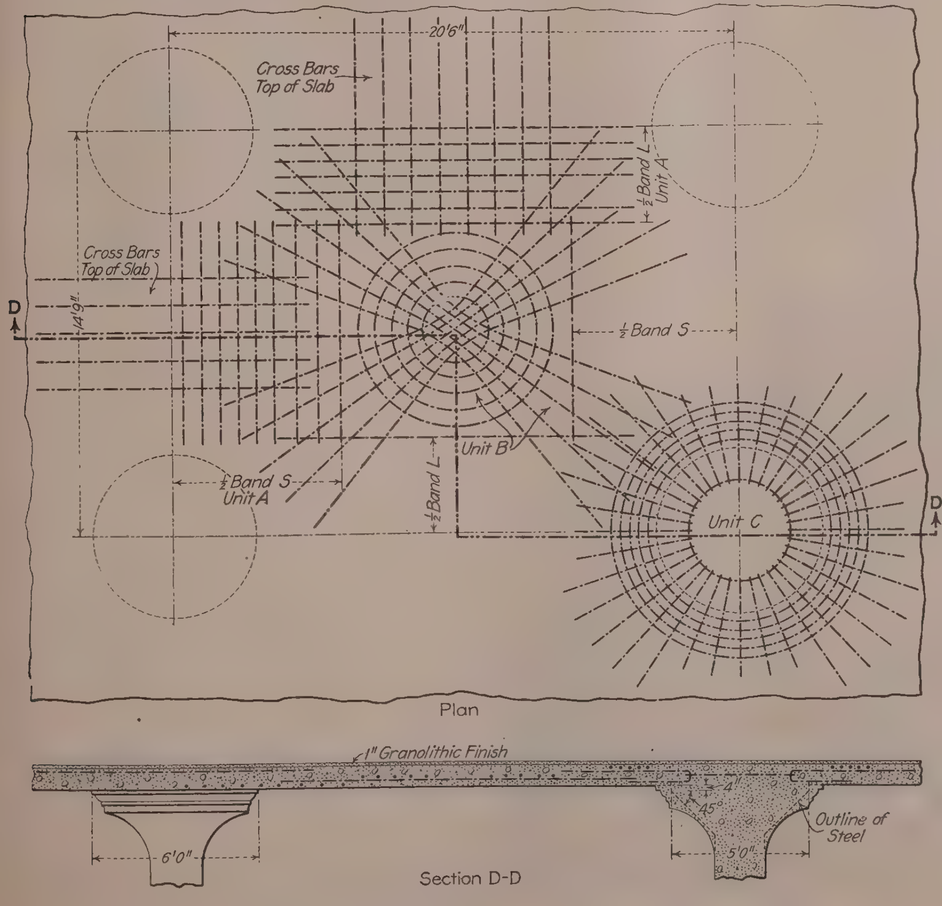
FLOOR THICKNESSES AND LOADS

Three standard thicknesses of floor slab were used: a 9-in. slab for the second floor, which carries the heavy printing presses, designed for a live load of 300 lb. per square foot; an 8-in. slab for the basement over the sub-basement, and for the first, third and fourth floors, which will be used for storage rooms and the remainder of the printing plant, designed for 200 lb. per square foot live load; and a 7-in. slab for the fifth and sixth floors and the roof, designed for a live load of 100 lb. per square foot, with special design under heavy vaults. These upper floors are used by the business department.

All floors have a 1-in. granolithic finish, cast after the structural slab had set.

FLOOR-SLAB REINFORCEMENT

The floor reinforcement for each type of slab is patented and is known as the Smulski or S-M-I system. It consists of three separate units as indicated on the drawing; unit *A*, a series of short rods at the bottom of the slab, which form the cross bands; unit *B*, the bottom steel at the center of the panel, and unit *C*, the top steel over the column head. The arrangement of steel in this floor design is patented.



SKETCH PLAN AND SECTION, SHOWING UNITS IN TYPICAL PANEL

Unit *A* for interior panels consists of ⅜-in. round rods 8 ft. long for the short sides of the panel and 13 ft. long for the long sides, bound together at the specified spacing by two and by three ⅜-in. tie rods respectively. The number and spacing of the rods in these units is varied according to the loading. For the exterior panels ⅝-in. and ½-in. round rods are used. Unit *B* consists of five concentric rings, spaced 7 in. apart, and two sets of five rods each placed in a diagonal direction, and slightly curved as shown. The ends of the rings, which are deformed rods, are looped forty diameters to form the splice. Unit *C* consists of six concentric rings and from thirty-six to forty radial rods, bent in a U shape with unequal length of prongs, the upper prong being the longer and serving as tension reinforcement, the shorter, lower prong serving as compression reinforcement.

All the radial rods over the column heads (unit *C*) are looped around a center ring 3 ft. 8 in. in diameter, which consists of either a 1-in. or a ⅞-in. round rod. The remaining five rings are placed on top of the radials and wired to them as illustrated in the photographs. These rings are lapped and two prongs bent down to reach the bottom of the form to keep the unit at its exact height and position. The single heavy ring serves two purposes: It carries the stress at the column head, and serves to stiffen the unit as a whole during construction and erection. The radials vary in length and size according to their position; those in the diagonal direction take the largest stress and hence are large rods spaced close together, extending farther out from the column head than those parallel to the long side of the panel, which are of the same size, but spaced farther apart; the shortest radials are parallel to the short side of the panel.

WALL AND CORNER UNITS *C*

The wall units and corner units *C* are, in general, one-half or one-quarter of the whole column unit *C*, and are composed of half or quarter rings and the proper number of radials. The center ring is hooked into the columns and the radial bars are looped about it; the other rings are hooked or anchored into the spandrel beams. These spandrel beams are 15 x 20 in. and are reinforced to carry the wall loading and to prevent temperature cracks. Roof beams are designed as part of the cornice of the building and each tower has an arched beam at the roof level.

Secondary reinforcement of 3/8-in. round rods 8 ft. long over the long cross bands and 10 ft. long over the short cross bands of the *A* units is placed at the top of the slab to resist negative bending moment over these bands at right angles to them.

FABRICATING THE UNITS

Units *A* and *C* were fabricated in the yard on templates and stored there until ready for use. Wooden plugs or nails were used to locate the exact position of the rods, and assembly was rapidly accomplished. One photograph shows a *C* unit being assembled, and another show how it appears when in place. These units were assembled by first placing the center ring and looping the radial rods around it, locating them according to marks on the template frame.

The *B* units at the center of the panels were easily wired together on the forms. The center of the panel was marked and the diagonal rods were placed on the forms at their required spacing, after which the concentric rings were placed over them and wired in place.

In placing a floor panel of reinforcement the bottom units *A* and *B* were placed first and the upper units *C* over the columns last.

ADVANTAGES CLAIMED—THEORETICAL AND PRACTICAL

Theoretically, it is claimed, this system of slab reinforcement insures the placing of steel in the most effective directions to resist stresses. At the column head the stresses act both radially and circumferentially. The radial rods take the radial stress and the rings, in addition to resisting circumferential stress by hooping action reduce the radial stress and tend to prevent cracks around the head. Another claim is that compression reinforcement at the column head required by the very large compressive stresses is very effectively provided for by the lower prongs of the radial bars placed in the direction of these compressive stresses.

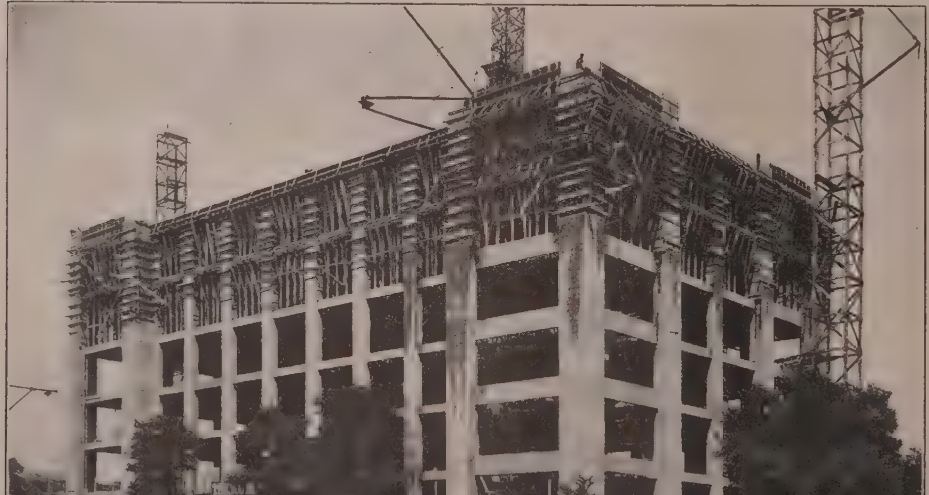
In unit *B* the diagonal bars converge toward the center, thus concentrating the maximum amount of steel at the center of the slab where the stresses are largest. By spreading their ends they reinforce the parts of the slab not covered by the rings and transfer the load directly to the column head.

The center ring of the *C* units over the column head is large enough in diameter to avoid interference with column reinforcement and to allow pouring of the concrete into the column shaft. It is pointed out that this center ring is also of special advantage when a large number of rods is required and where structural steel columns are used. Furthermore, the spacing of the rods in this unit allows room for flow of concrete around all the steel and avoids the massive screen of reinforcement over the column head found in the usual two-way and four-way systems.

ASSEMBLING UNIT *C* ON TEMPLATE

FORMS AND CONSTRUCTION

Ordinary wood forms were used for the footings, the basement walls and the wall columns. The floor forms were built of 18-gage metal nailed to 2 x 3-in. joists spaced 4 in. apart and supported by wooden bents about 7 ft. 6 in. on centers. Metal forms were used for the columns and ornamental column heads.


TOWERS AND CHUTES USED IN POURING REINFORCED-CONCRETE FRAMEWORK

Gravel concrete was used throughout for the structural frame and floors. The construction plant was located about 10 ft. below the roadway level in the rear of the large lot. Concrete materials were wheeled in 5-ft. hand carts to the 175-ft. main mixing tower located at the rear and at the center of the building. Two supplementary towers, one at each end, were connected to the main tower by wire cables. The concrete was distributed by a three-joint metal chute rigged from these cables.

The architects and engineers in charge of the construction are Densmore & LeClear, of Boston. The reinforcing of the floor slabs was designed by Edward Smulski, of the S-M-I Flat Slab System Company, in connection with the office of Sanford E. Thompson, consulting engineer, of Boston. The contractors are the W. F. Kearns Company, of Cambridgeport, Mass.

Water Slopes of Earth Dams Protected in Novel Way

Arthur P. Davis and D. C. Henny Describe Interesting Experiment on Large Embankments of Deer Flat Reservoir

DIVIDING dams into two general classes, masonry and earth, Arthur P. Davis, chief engineer, U. S. Reclamation Service, and D. C. Henny, consulting engineer, Portland, Ore., in their paper on "Dams," presented before the recent International Engineering Congress, review briefly the leading developments in both types of construction. In their discussion of earthen dams, the following paragraphs are especially suggestive:

The protection of the water slope of earth dams is always an important and expensive problem, especially under the circumstances which often obtain in the West, where rock is not at hand, and the costly rail and wagon haul make cement for concrete paving expensive.

An interesting experiment is now in progress on the two large embankments that form the Deer Flat reservoir of the U. S. Reclamation Service, which have a gravel facing. Wind action produced peaching and wearing down of materials. No rock was within reach for riprap. The embankments were widened at the top to a total of 60 to 70 ft. by dumping gravel on the 3:1 water slope from cars, which was then allowed to lie at its natural angle of repose, to be worked down the bank by the waves. Wave action is expected to work the gravel down the slope gradually, the fine silt and sand settling in the bottom of the reservoir where it is much needed to check seepage under the dam, the coarsest material remaining on the slope. The degradation of the bank has been much slower than was expected, and the extra top width has nowhere been reduced as much as 25 per cent, and in some places hardly at all, in spite of the fact that the largest cobbles do not exceed 5 in. in length and the reservoir has a very large wind exposure.

Indications along the natural gravel slopes of the Wachusetts reservoir are that permanent slopes in such circumstances will assume an inclination of 1 to 4 or 5, in which case further gravel may have to be deposited on the Deer Flat embankments in the future, or other protection provided.

Cushionless Brick Pavements, Built as Monoliths by New Method, Win Widespread Favor

Many Road Engineers Are Revising Former Practice by Omitting Sand Cushion and Using a Thin Bed of Mortar to Support Blocks Laid and Rolled Before Concrete Base Has Hardened

IT seems probable, although it is still too early to say the final word, that a general revision of practice in the construction of brick pavements will be the outcome of the work at Paris, Ill., last summer, where the usual sand cushion was replaced by a thin layer of dry mortar and the blocks laid and rolled before the concrete base had hardened. This work was described in the Engineering Record of July 10, page 54, and editorial comment on the new monolithic form of construction appeared in the issues of July 3, page 3; July 17, page 64, and Sept. 11, page 311. Evidence of further confidence in what may be termed this "cushionless" type of construction is contained in the following articles. One, a paper presented at the Northwestern Road Congress this week by Rodney L. Bell, division engineer, tells of the work done by the Illinois State Highway Department. D. Moomaw cites the experiences of Cuyahoga County, Ohio; and F. A. Churchill sums up the arguments against the sand cushion and tells how the monolithic construction eliminates rumbling and wear. Information is given also on work of this type done in other localities.

Illinois Finds New Mortar Bed an Improvement

Paper by Rodney L. Bell, Division Engineer, Illinois Highway Department, Presented at Northwestern Road Congress in Grand Rapids, Mich., This Week

SINCE the first monolithic brick road was laid April 1 and 2, 1915, at Paris, Ill., according to Mr. Bell, our common enemy, the so-called sand cushion, has found some very strong and able defenders. Mr. Bell was of the opinion that every one conceded the only reason for the layer of sand between the concrete base and the brick wearing surface was to take up the irregularities in the concrete base and the paving block, but it seems there are those who believe that it acts as a cushion. With the old type of construction, when sand or asphalt filler was used and each brick might act at least partially independent of the other, this might have been true, but if the sand acts as a cushion it must give or move, and this is fatal to cement grout filled brick road.

Baltimore constructed a street some four or five years ago and in place of using the ordinary sand cushion, a dry mortar cushion, 1 part cement to 5 parts sand was used. This cushion was spread on the concrete base, struck off to a thickness of 1 in., as in ordinary construction. The brick were then laid and rolled, after which water was applied on the top of the brick in sufficient quantity to set the cushion.

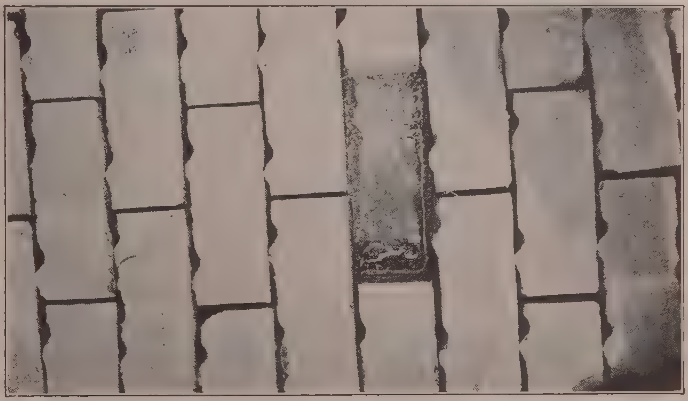
St. Louis is putting in some of the same kind of work this year, except that a 1½-in. dry mortar cushion is used; the cushion is made up of 1 part cement to 4 parts sand. In 1914 there was laid in Cleveland, Ohio, a strip of pavement which was along the same line as the work done in Paris, Ill. The 6-in. concrete base was laid and 5-in. brick were immediately placed on the green concrete, rolled by a light roller and grouted. This pavement was put in by a cold storage company but the name of the company or the exact location is not a matter of record. In the Pennsylvania Terminal in New York there is an example of this work which was laid on a dry mortar cushion. The brick were only 2½ in. thick and were fire clay brick. Mr. Bell has been told, but has been unable to verify it, that paving of the same kind has been laid in Springfield, Mo., along the street car tracks. It is very probable that other work has been done along these same lines of which there is no record.

Where grout filler is used the sand cushion is not so much a convenience as it is a constant source of annoyance and worry, if the work is to be properly constructed. One specification provides that sand must not be rolled up between the brick more than ½ in. This means that any brick pavement that receives a rain before the brick has been rolled may have to be relaid. It makes inspection exceedingly difficult in that it is hard to tell just where to draw the line.

The Illinois Highway Department does not use cross expansion joints and believes, according to Mr. Bell, that they are not only useless but destructive to brick roads. The cross expansion joints allow the pavement to move and this movement should be avoided. A pavement without cross expansion joints does not move in expansion if it is properly confined; it only tends to move. The force is always there, however, to move it when the restraints are removed. A good illustration of this was seen at Paris this summer. A brick road with no cross expansion joints, 4500 ft. long and 17 ft. wide was laid on a 1-in. sand cushion, terminated at one end against an 80-ft. steel bridge. Due to the construction of a new dam it became necessary to remove this bridge and put in a new one 8 ft. higher than the old structure. This necessitated the removing of 400 or 500 ft. of the road. Just as soon as the brick were removed the pavement began to creep and has moved 3 or 4 in. since the restraint was removed.

Mr. Bell, last summer, visited a pavement that had blown up at Chrisman, Ill. This pavement was constructed in 1914, the brick being laid on a 2-in. sand cushion and rolled with an 8-ton roller. An examination of the brick that had blown up showed that in a majority of the cases the sand had been rolled up between the brick at least one-half the depth of the brick, or about 2 in. To any one familiar with what brick will do under such conditions it is no wonder at all that this pavement refused to stay in place.

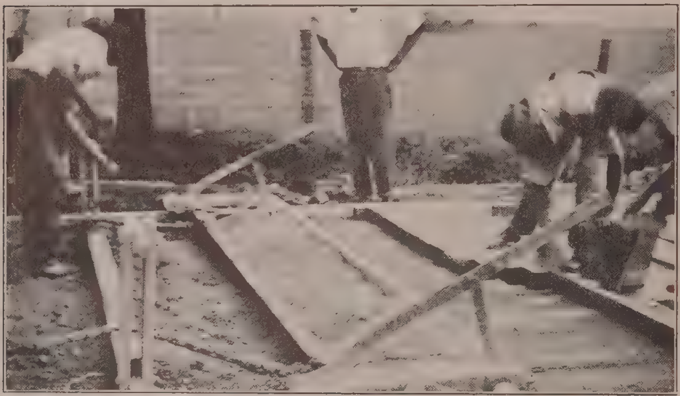
GROUT FILLER EXTENDS TO BOTTOM OF THE BRICK, THUS BONDING THE WORK INTO A SOLID MONOLITH


ONE BRICK REMOVED TO SHOW WATER FILM WHICH ROLLING HAS BROUGHT TO TOP OF CONCRETE BASE

In order to get away from the constant worry of how the sand cushion was acting the new type of pavement was developed. W. T. Blackburn made the first sample of this work and the details of the construction have been worked out by A. J. Parrish, a contractor of Paris, Ill. [The work is described in detail by Mr. Blackburn in the Engineering Record of July 10, page 54.]

MONOLITHIC WORK AT PARIS

When the weather stopped the State-aid work in Edgar County in 1914 the department had enough donated money left to build 400 ft. of 10-ft. brick road. When this construction was brought to Mr. Bell's attention he immediately secured the consent of the State engineer to build this 400 ft., using the monolithic type of construction. The work was started April 1, 1915, and 200 ft. were laid; the remaining 200 ft. were laid April 2. Since that time there has been constructed in and near Paris 13,150 sq. yd. of this type of brick road and there is under contract at the present time 11,780 sq. yd. of State-aid work which will be constructed this year. Before starting work this spring doubt existed as to how the new method would work out in practice. It not only worked out satisfactorily but it is an easier means of construction in every way than the old method.



LEFT — TEMPLATE BY WHICH DRY MORTAR MIX IS SPREAD ON GREEN CONCRETE BASE JUST IN ADVANCE OF BRICKLAYING

In the preparation of the subgrade on the Illinois construction the rough work is generally done with a traction engine and a grader, the engine thoroughly compacting the subgrade. The subgrade is dressed up by hand, after which a 5-ton, self-propelling roller is kept constantly at work while the material is being hauled. Steel forms 8 in. in depth and 12 ft. long are then set true to line and grade. The concrete base is 4 in. thick and the brick are 4 in. in depth, making, when completed, an 8-in. monolithic pavement. Steel forms, while not absolutely essential, are a great convenience in this type of construction, according to Mr. Bell.

SPECIAL TEMPLATE FOR BASE

The concrete for the base was a 1:6 mixture of cement and washed gravel. The gravel tested very close to 50 per cent. through a ¼-in. square mesh. The base for the State-aid work now under contract will be 1 part cement, 3½ parts fine aggregate and 6 parts coarse aggregate. Enough water is used so that the concrete is of a quaky consistency, but will not flow. It was found that an excess of water caused no trouble in keeping the brick up to a true surface.

In order to get approximately the right thickness of concrete before cutting it with the template a small wooden guide is used. The steel template used is necessary in order to secure accurate results on this type of work. This template is made up of a 6-in. I-beam in front and a 6-in. channel behind. They are placed 2 ft. apart and supported by four rollers, one at each end of each member. The rear edge of the template is set exactly 4 in. below the top of the forms and the front edge is set 4 3/16 in. below the top of the form. The hopper-like space between the two edges is kept filled with a dry mix consisting of 1 part cement to 5 parts sand. The template is drawn forward by means of a cable and a friction clutch on the mixer. As the template is drawn forward the front edge cuts the concrete 3/16 in. below grade and a thin film of dry mortar is spread over the concrete, filling all the little depressions in the surface. Theoretically, the dry mortar coat should be exactly 3/16 in. in thickness. In reality it does not have any noticeable thickness but is sufficient to give a perfectly smooth surface for the brick.

LAYING THE BRICK

Practically the only place where more care need be taken with this type of construction than where a sand cushion is used is in the laying of the brick. It is essential to have the brick rolled within 20 to 30 min. after the concrete base is laid and to do this culling must be reduced to a minimum. The carriers are required to deliver the brick to the setter so that he can easily lay them in the road with the good face up and the lugs all one way. In this way most of the culling is done by the carriers and but very few brick need be turned after they are placed in the road. It is necessary for the setter to use a little more care than where a sand cushion is used, he is the only man in the gang who does not work at top speed. It is advisable to have two planks, 1 x 12 in. and of a length equal to the width of the pavement, for the carriers to use when coming on the pavement. This saves tracking dirt on the brick and also prevents uneven places in the pavement, due to the fact that the carriers will all come on the pavement at about the same place.

As soon as the brick are laid the necessary culling and batting is done, the pavement swept and rolled. A two-section roller, 30 in. long and 24 in. in diameter and weighing about 750 lb. is used. This roller is easily handled by one man and leaves a much better surface than it is possible to secure with the old type of construction. The brick are not embedded more than ¼ in. in the base.

GROUTING JOINTS

A 1:1 mix of cement and sand is used for the grout filler. This is mixed dry in a small batch mixer and then conveyed to the grout boxes on the pavement by means of wheelbarrows. The maximum size of batch allowed in the boxes is 2 cu. ft. of the mixture. Water is added slowly and the mortar built up gradually, after which it is thinned to a consistency that will flow readily into the joints. The grout is stirred constantly while being removed from the boxes with scoop shovels. The joints are filled completely at the first application, but after settling the top of the grout is about ½ in. below the top of the brick. Before the first application has taken its initial set the joints are filled a second time. The second application of the grout is mixed to a consistency of thick cream. In making this second application enough surplus is left on the road so that the surface can be gone over again without bringing the boxes back. The surface is finished with a squeegee, the joints being entirely filled.

RIGHT—WHERE ONE DAY'S WORK HAS ENDED AND ANOTHER BEGUN ON MONOLITHIC CONSTRUCTION

In order to secure the best surface the squeegees are pulled over the road at an angle of 45 deg. with the joints. This prevents the squeegee from dragging mortar out of joints and leaving them lower than the surface of the brick. The pavement is covered the following day with ½ in. of sand or earth which is kept wet at least 5 days. The side forms are removed the second day. The pavement is allowed to set 10 days before the side roads are graded and three weeks before being opened to traffic.

ADVANTAGES OF NEW TYPE

The advantages of the monolithic type of construction are the following: A better surface can be obtained; the work is easier on both contractor and inspector; there is no guess work at any point of the construction; under similar conditions it represents a saving of from 10 to 12 cents per square yard over the old method; it eliminates the breaking down of the filler at a construction crack, as each brick has a rigid support; it opens the field for experiment with thinner brick; the filler is sure to reach the bottom of the paving block; there is no need of a flush curbing; rumbling in brick pavement is eliminated.

Ohio Uses Cement-Sand Support for Brick Pavement

Method Provides Firm Support for Surface Which Does Not Shift Under Jar of Passing Traffic

By D. MOOMAW
Road Engineer, Cuyahoga County, Ohio

CUYAHOGA County, Ohio, has completed or under construction 51,160 sq. yd. of brick pavement and 11,900 sq. yd. of granite pavement in which the cement-sand cushion is used. This cushion, which replaces the old sand cushion, consists of a dry mixture of cement and sand in the proportions of one bag cement to 3 cu. ft. of sand, thoroughly mixed and spread upon the concrete foundation. The cushion is then shaped and rolled in the same manner as has been employed for sand cushion. The brick are laid, culled and rolled in the usual manner before adding water to the mixture. The depth of the cushion is specified as 1 in. after rolling. After rolling, the cushion is sprinkled with a spray until the cushion is wet through. Grouting of the pavement may follow the sprinkling or may be delayed until the cushion has hardened.

PURPOSE OF CUSHION

The purpose of a cushion between the foundation is to permit the forming of a smooth and regular pavement surface. When sand is used as a cushion, the sand remains in the completed pavement, a serious weakness and a source of much trouble. It is to eliminate this trouble that the cement-sand cushion is now employed. It has been clearly demonstrated that the shifting and yielding of the sand cushion is the cause of failure of the surface bond over large areas, and that freezing and thawing of water in the sand cushion is a fruitful source of longitudinal cracks. To perform the function of the sand cushion and at the same time correct its evils, the cushion must be yielding during construction, and dense, firm and unyielding after the pavement is completed. These properties cannot be more easily obtained than by the use of sand and cement. The ingredients of this cushion should be of such quality as would render them suitable for use when a good grade of concrete is desired.

CEMENT-SAND PROPORTIONS

In some places where this type of cushion has been tried the cement and sand have been used in the proportions of 1:4 and 1:5. A careful analysis of the object to be gained will show such mixtures to be too lean. The primary object of this cushion is to secure a bottom support to the brick sufficiently rigid to insure the integrity of the grout filler, and second, more completely to exclude water from the vital parts of the structure. As we decrease the cement below the proportions necessary to fill the voids in the sand, we increase the porosity and decrease the strength of the mortar, thereby decreasing the efficiency of that part upon which depends the life of the pavement. A 1:3 mix is about the upper limit of proportions upon which we can fairly well depend upon the filling of the voids of sands not especially compounded. A dry mix is necessary because of the unavoidable lapse of time between the preparation of the cushion until the rolling and culling have been completed, during which period it is necessary to have the cushion free from hardening.

The thickness of cushion required is the minimum depth that can be depended upon to overcome the irregularities of the concrete foundation and variation in depth of the paving block. A 1-in. depth is found to be ample upon a concrete base that is finished with reasonable care and with an allowable variation of ¼ in. in depth of block. With less than 1 in. considerable difficulty is experienced in bringing the brick to a smooth even surface. The cushion should be rolled with a hand roller before the brick are dropped. As the mixture is easily compacted, it is not necessary to roll as much as will be required for dry sand. Rolling prevents the splashing of the dry mixture when the brick are dropped, and prevents the cushion rising in the joints when the brick are rolled.

ROLLING BRICK

Specifications for rolling the brick call for rolling only enough to obtain a smooth even surface. This may be accomplished with a hand roller, but it is now recommended on work in this county that a 5-ton steam roller be used, because by so doing the cushion is given additional compression which will add to the density and strength of the cushion. When the hand roller is used, somewhat better results can be obtained by sprinkling the pavement immediately before rolling. In that case the cushion should not be thoroughly saturated until the rolling has been completed.

Water should be applied in a spray, or at least not in a direct jet or by dashing it on with pails. The force of the water should not be such as would displace the cushion or wash the cement out of the sand. Wetting the cement-sand cushion should be very carefully attended to, as too light an application will leave a portion under the middle of each brick dry, and too free a use of water will so soften the cushion that the brick will settle of their own weight and cause roughness of the pavement. Several applications of water with frequent examination will give the best results.

When the sand is slightly damp the cushion should be prepared but a short distance ahead of the droppers and the culling and rolling carried on as expeditiously as possible, so that setting of the cement need not be disturbed after it has started, and that the cushion may suffer no ill effects from partial hydration of the cement. With the use of the cement-sand cushion the method of grouting should be modified to correspond to the new conditions. The cushion being rigid and nearly impervious, it is recommended that the application of thin grout be omitted entirely and that the joints be filled as completely as possible with the one application, finishing with a second application if necessary.

The advantages of this type of construction over the old are:

1. We secure a fixed unyielding support under the rigidly bonded wearing surface, a support that does not shift under the jar of passing loads.

2. We reduce the capacity of the pavement for absorbing moisture.

3. The cushion becomes a part of the rigid structure, gives a partial bond between the wearing surface and the foundation, and thereby increases the strength of the structure.

4. It presents a new distribution of the vertical forces, and hence a new distribution of the stresses in the pavement, bringing the strength of the foundation into play in such a way as to reduce the stresses in the grout-bonded surface to a point where we can depend upon there being a fair factor of safety.

The pavements of this type constructed in Cuyahoga County, have not been in use long enough to ascertain whether or not there will result a noticeable reduction in the noise produced by traffic or if the use of the cement-sand cushion will offer advantages or disadvantages under thermal and humidity changes.

Alternate bids received on sand and cement-sand cushion for brick pavement show a difference of from 5 to 35 cents per square yard, the higher figure no doubt being that of a skeptical contractor, and the lower being decidedly under cost. An intelligent figure is between 15 and 20 cents per square yard, depending upon the location of the job.

Rigid Bed Eliminates Noise and Subsurface Pockets

Cement-Sand or Mortar Layer Eliminates Objectionable Rumbling and Possibility of Settling of Blocks Undermined

By F. A. CHURCHILL
Dunn Wire-Cut-Lug Brick Company, Conneaut, Ohio

SAND beds for brick pavements seem destined to be relegated to that discard whence no abandoned engineering device returns. It is yet too early to venture a positive prediction concerning the ultimate fate of sand beds, but recent developments seem to warrant the belief that cement-sand beds and mortar beds will eventually supersede sand beds in the favor of highway engineers.

Theoretically, the function of a resilient cushion under the brick pavement is twofold: It is supposed to distribute the shock of traffic impact, which, it is alleged, is transmitted through the brick surfacing to the foundation; and it is contended that a sand cushion prevents crushing of the brick under the weight of traffic. Many engineers have questioned the soundness of this theory, but as the sand bed has been regarded, until recently, as indispensable for leveling the surface of foundations, the question of resiliency has been held in abeyance.

The cement-sand bed, now excluding all other beds in the city of Baltimore and coming into general favor, and the mortar bed imposed upon a green concrete foundation, as exemplified on State highway work in Edgar County, Ill., have proved equal to the sand bed in compensating the inequalities of foundations, and they are self-evidently superior to the sand bed in obtaining true monolithic construction. The practical value of resiliency is, therefore, the last defense of the sand bed. If the argument for resiliency falls, the sand bed must go. If we grant the need of a shock-absorber between the pavement proper and the foundation, the concession is the end of the discussion.

IS A CUSHION NECESSARY?

Is a cushion necessary? A mathematical formula may validate the claim, but every engineer knows that actual facts cannot always be expressed by a mathematical formula, nor do the facts of experience and the conclusions of mathematical calculations always agree. If the theory of resiliency is submitted to the test of pure reason, certain factors appear. First, a grouted brick pavement, being bonded into a single slab, is itself a distributor of shock. Second, a brick pavement describes a segment of a circle; the crowning of the pavement for surface drainage purposes introduces the arch principle, thereby not only minimizing the direct transmission of shock to the foundation, but also strengthening the pavement's resistance to the impact of traffic. A concrete example of the upstanding strength of a grouted brick pavement was furnished in Cuyahoga County, Ohio, not long ago. A flood washed from under a grouted brick highway the subsoil and the foundation for a linear distance of 50 ft. and to a depth of over 6 ft., but the 4-in. brick pavement sustained the weight of a touring car by virtue of the strength given it by the bond and the arched construction.

Shock Transmission

It is not consistent with reason or with facts attested by experience and observation, to assume that a well-grouted, crowned brick pavement can transmit to the foundation any appreciable shock—a shock sufficient to shatter the concrete. Nor is it credible that such a pavement with a solid beam would more easily crush under the weight of traffic than it would with a double beam divided by a sand cushion. Mere weight does not crush a grouted brick pavement laid on a concrete foundation, either with or without a sand cushion. Sharp-edged iron tires, if bearing a very heavy load, may cut into the surface of brick not adequately vitrified, but there is no recorded instance of a grouted brick pavement supported by a concrete foundation crushing down under traffic. If paving brick manufacturers could not make a paving brick that would bear the crushing force of street highway traffic, the paving brick industry would collapse.

A cement-sand bed on a set-up 6 in. concrete foundation, or a mortar bed on a green 6-in. concrete foundation, gives a monolithic pavement approximately 11 in. deep, including a 4-in. vitrified brick wearing surface. Reason rejects the assumption that such a pavement is likely to break down under traffic because of a lack of resiliency. The life of a brick pavement continues as long as the bond holds. Rigidity to a depth of 11 in. seems more likely to safeguard the grout filler than does a resilient cushion of sand under the pavement crust. If there is a resilient motion in the sand cushion, a like action of the brick is inevitable. Even a slight springing motion imparted to a brick slab bonded by hardened concrete has at least a strong tendency to break the joint.

Neither vitrified brick nor cement-grout possesses the properties of flexibility or elasticity in such degree that when bonded with the other it can withstand the fracturing effects of a continuous springing motion. If the degree of resiliency is not sufficient to affect the bond injuriously, it is not easy to understand how the resilient function of a sand cushion can offset the damage done a pavement by the shifting of the sand cushion, and the settling of the sand in spots on account of the absorption of excess moisture content. It is well known that sand beds frequently do settle in small areas, leaving the pavement unsupported at such points. The consequence is an unpleasant rumbling and the positive assurance that if the bond breaks the pavement will seek the depressed sand bed by settling.

Little Noise with Mortar Bed

Recent experiments have demonstrated that the noise made by iron-tired vehicles in passing over brick pavements is due to the sand bed. Hollow rumbling has been believed for a long time to be caused by the sinking of the sand bed away from the surfacing material, but now it is known that an ordinarily noisy brick pavement is noisy because of lack of a solid bearing for the brick.

The demonstration has been made at Paris, Ill., by W. T. Blackburn, consulting engineer of the Dunn Wire-Cut Lug Brick Company of Conneaut, Ohio, and A. J. Parrish, contractor. The construction of brick pavements, with a thin mortar bed upon a green concrete foundation, the brick being immediately laid, rolled and grouted, has solved the problem of how to eliminate noise. Iron-tired vehicles passing over these pavements make hardly any noise.

One such pavement, 30 ft. wide, joins a second one, brick constructed, with a concrete foundation and a $1\frac{1}{2}$-in. sand bed. The same make of brick is used in both pavements, and the same contractor and engineer were in charge of both pavements. Recent experiments were made by several prominent engineers and city officials from various cities, and, as one of the visitors said, "One can tell almost the course of brick when one leaves the almost silent mortar-bed pavement and strikes the noisier sand-bed pavements."

The elimination of noise by the construction of a solid beam from surface to subbase, is an additional reason for predicting the passing of the sand-bed from the ken of highway engineering.

Furthermore, one of the troubles incidental to the construction of brick pavements with sand beds is the tendency of the brick to spawl and break at the point of abutting against another type of pavement. This trouble entirely disappears when the rigid type of construction is used. If the brick, the mortar, or cement-sand bed and the concrete foundation are united in a single rigid beam the end course of brick in a pavement is supported as firmly as any other portion of the pavement, and the tendency to break away from another type of pavement is overcome.

Careful tests of the mortar-bed pavements have apparently established these facts beyond question, and these facts constitute another argument in favor of discontinuing the use of sand beds which will appeal to the practical highway engineer.

Monolithic Pavement Carries Heavy Traffic at Cleveland Plant

In 1914 the paving at the ice-cream plant of the Telling Brothers Company, in Cleveland, was laid with brick on a mortar bed. The work was done by the City Paving & Construction Company under the direction of James Banwell, who reports that there is not a loose brick in the job to-day. The brick were tamped into the 6-in. concrete base and asphalt strip expansion joints were placed at frequent intervals. This pavement is subjected to the brine-drippings from ice-cream cans and is traveled by heavy trucks.

MONOLITHIC PAVEMENT, SUBJECTED TO HEAVY TRUCKING AT CLEVELAND ICE CREAM PLANT, HAS STOOD UP WELL

Other Examples of Mortar Bed Brick Pavement

On the heavily traveled approach driveways and inclines at the Pennsylvania Terminal in New York City the bricks were bedded in cement mortar mixed 1:3. The bricks are of fire clay, made at Clearfield, Pa. On the inclines they are $7\frac{1}{4}$ x $2\frac{1}{2}$ x $2\frac{3}{8}$ in. with beveled edges, and no lugs. They were, however, carefully laid by ma-

BRICK PAVEMENT CARRIES HEAVY TRAFFIC AT PENNSYLVANIA STATION, NEW YORK

sons and separated so that the mortar or grout could be placed readily in the joints. This pavement, laid in 1910, has never been taken up for repairs. There are no cracks in it.

The city of Canton, Ohio, is using a 1-in. cement sand cushion on all track work on West Tuscarawas Street, which is now nearing completion.

The city of Baltimore, Md., for a long time has laid all brick gutters on streets paved with sheet asphalt, on a mortar cushion.

Cement-Sand Bed Used for Granite Block in Philadelphia

By C. B. FAIRCHILD
Executive Assistant, Philadelphia Rapid Transit Company

THE Philadelphia Rapid Transit Company has never laid any brick pavements on a mortar bed instead of a plain sand cushion, except in a few isolated cases which would be of little or no use as indicating the advantage or disadvantage of that method. George B. Taylor, engineer of this company, states, however, "that during the years from 1904 to 1907, in connection with some of our concrete track construction, we did pave between rails with granite blocks, which were laid on a dry mixture of cement and sand, in a proportion of about three of sand to one of cement, and after the blocks had been set and properly rammed, a coating of gravel was spread over the surface and the entire pavement flushed with water, the water serving the double purpose of flushing the gravel in through the joints and at the same time providing the necessary water to form a mortar of the sand and cement bed.

"This was done on several heavily traveled streets in the center of the city, a large part of which exists at the present time. The surface of the paving has been maintained in very good condition but, of course, the exceptionally heavy traffic of nine to twelve years has rounded the corners of the blocks."

VALVE EXAMINERS IN CINCINNATI in 1914 found 208 valve boxes covered. Four men devote their entire time to this work, which is largely required because the boxes are covered when street repairs are made.

Literature

For the Civil Engineer and Contractor

New Publications

PUBLIC UTILITIES—THEIR FAIR PRESENT VALUE AND RETURN. By Hammond V. Hayes, Ph.D., consulting engineer. Cloth, 5¼ x 8½ in. New York, D. Van Nostrand Company. $2 net.

BUILDING CODES—SOME PERTINENT SUGGESTIONS. By Virgil G. Marani, former building commissioner, city of Cleveland. Paper; 4 x 6 in.; 16 pages. Cleveland, published by the author, 1900 Euclid Avenue.

Helpful suggestions relating to fire protection for cities seeking reliable data in formulating a safe and sane building code. Urges strong effort to make general standards of engineering and architectural practice the accepted basis for all building codes.

Books Reviewed

Irrigation Practice and Engineering —Volume I

Author, B. A. Etcheverry, head of the Department of Irrigation, University of California. Cloth, 9½ x 6 in.; 213 pages; 77 illustrations. New York, McGraw-Hill Book Company, Inc. $2.

Reviewed by F. H. Newell
Head of Civil Engineering Department, University of Illinois, Urbana.

This, the first and presumably the smallest of three volumes being prepared by Professor Etcheverry, brings together in readily accessible form the result of the more recent investigations and experience in handling water used in irrigation. It starts with the assumption that the man who consults it has already had considerable experience in irrigation, and knows the principal facts concerning the use of water. It plunges into the fundamentals of distribution of moisture in the soil and the influence of the character of the soil upon the availability of this water for plant use. It then takes up and illustrates quite fully the effects which follow when water is applied to the soil and shows by well-arranged diagrams how the water percolates downward and laterally from the point of application.

Professor Etcheverry quotes quite fully from recent investigations on water requirements for irrigating crops and brings out, by diagrams, the fact that with a moderate amount of water good crops are obtained, but with more water the increase in yield is not in proportion to the amount used. On the contrary, a point is quickly reached where with more water the increase in yield stops or becomes negative. These conclusions on the subjects investigated are perhaps the most important, not only for the information of engineers in designing works, but even more for the manager of such works when built. Here the latter finds his more difficult problems, not in securing an adequate amount of water, but in convincing his customers, the irrigators, that while a little water is a good thing, plenty may be injurious to them and to their neighbors.

The time to apply water and the frequency of irrigation are discussed, leading up to what the engineer terms the duty of water, or the relation between area of land served and quantity used. On these points there have been brought together a wide range of data, convenient for reference.

Going further into details, the book discusses the preparation of the land for irrigation, the methods of distributing the water and concludes with some elementary facts and costs on pumping water for irrigation.

The treatment of the subject is simple and direct, enabling any man of fair intelligence to grasp the important features. At the same time the arrangement of the book facilitates the search of the busy engineer for facts and conclusions in his efforts to secure better use of water. A strong feature is the care with which the data have been arranged and the completeness of the illustrations. The subject which it treats is still in the making, and the book presents clearly our present stage of knowledge of a rapidly evolving phase of engineering and agricultural development.

Surveying Manual

Author, William D. Pence, professor of railway engineering, University of Wisconsin, and Milo S. Ketchum, dean, College of Engineering, and professor of civil engineering, University of Colarado. Leather, 4½ x 7 in., 388 pages. New York, McGraw-Hill Book Co., Inc. $2 net.

Reviewed by A. F. Comstock
Associate in Railway Engineering, University of Illinois.

The commendation with which this pocketbook has been received is attested by the fact that over 31,000 copies have been sold since the first edition was published in 1900. In this, the fourth edition, the authors have sought to increase the book's usefulness by appropriate revisions, by redrawing and enlarging the cuts, and by the addition of 130 pages of field and office tables. Two of the foregoing changes are particularly noticeable and doubtless will be greatly appreciated by the craft, i.e., addition of a complete set of tables, and enlargement of the lettering in the numerous sample field notes. The entire book has been reset, giving it throughout a clearer and more attractive appearance.

No deviation of note has been made in the text arrangement nor in the number of problems. Clearance and conciseness, which were so ably exemplified in previous editions, are well preserved in the present one.

New tables for meridian determination by observations on Polaris have been supplied. The field and office tables already referred to consist of five-place logarithms of numbers, logarithmic and natural functions, and a table of squares, cubes and roots—all conveniently arranged in the latter part of the book. Although there is but a trifling increase in the length of the book (the width remaining the same as formerly), the thickness has been increased by 136 additional pages over the previous edition. The obvious advantage of including the tables, however, more than offsets the disadvantage of greater bulk.

The authors are to be complimented on their latest efforts to maintain for this book the high standard of excellence achieved in previous editions.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Reinforced-Concrete Footings Economically Designed

Sir: In your issue of Sept. 4, 1915, page 300, you have an article "Reinforced-Concrete Footings Economically Designed." In the Engineering Record, Feb. 14, 1914, page 185, the matter of footing design has been carefully gone into by the writer from the standpoint of the latest experimental information then available. Up to the time Bulletin 67 of the University of Illinois Experiment Station was published footing designing methods were very unsatisfactory. From the results of these experiments it is seen that the punching shear is not so reliable a basis of figuring as the diagonal shear.

By analysis it is shown, in the article mentioned above, that if we assume 40 lb. per square inch as the working value for diagonal shear, which is conservative value, then the punching shear varies from 120 to more than 220, depending upon conditions of loading, the diagonal shear being figured, as suggested in Bulletin 67, on a vertical section at a distance equal to the depth of the footing from the side of the column shaft.

By the use of diagram 3 in the above-mentioned article it is a very simple matter to design a footing economically and safely. This diagram gives a value for K to be used in the formula $d=\sqrt{W/K}$, which is a similar formula to that often used in the design of beams. K varies according to the pressure on the soil and the unit load on the column section. For a soil pressure of 3000 lb. per square foot and a unit load of 500 lb. per square inch under the column shoe, K equals 640. Likewise, for a soil pressure of 6000 lb. per square foot and a load of 500 lb. per square inch on the column section, K equals 920.

Having found d, to which from 2 to 4 in. should be added, depending upon whether the soil is hardpan, or soft and liable to get churned up and nicked with the concrete, it is also easy to determine the necessary steel reinforcing, as given for various allowable soil pressures in a table on page 186 of the above reference.

Chicago. W. A. Hoyt.

How Glass Is Graded

Sir: In answer to the question, "How is glass graded?" asked by one of your correspondents in your issue of Sept. 4, page 302, I would say that the best quality of common American window glass is designated as AA, the second quality as A, and the third as B. The AA is supposed to be as good as can be made by the cylinder process. Common window glass is known technically as sheet or cylinder glass, because it is blown in the form of a cylinder. It is then cut longitudinally and flattened on a stone. Sheet glass can be distinguished from plate glass, even at a distance, from its wavy appearance, a defect which cannot wholly be avoided.

Common sheet glass is graded without regard to quality, according to its thickness, as single and double strength. Double-strength glass is of uniform thickness of ⅛ in. Single-strength glass may be as thin as 1/16 in. in thickness and not uniform. Both single and double strength are sorted into three grades, the classification depending upon color, brilliancy and flaws.

Polished plate glass, the highest grade of window glass, is cast in large sheets and rolled on a flat table, while the common, as before stated, is blown. Plate glass ¼ in. thick weighs 3½ lb. per square foot. Common window glass ⅛ in. thick weighs 2 lb. per square foot. Maze, prismatic, wired and ribbed glass have their different classifications also. We also have rubber glass reinforced on the inside with strong wire cloth. M. McEvoy.

Penn Yan, N. Y.

Air-Bound Filters

Sir: I would like to contribute the following discussion of Mr. Hoopes' paper on air-bound filters at Wilmington, Del., published in the Engineering Record of Sept. 4, page 282:

While water dissolves amounts of gas directly proportional to the pressure, these amounts are not directly proportional to the temperature, and, according to the best authorities, are indicated in the accompanying table.

Solubilities of Oxygen and Nitrogen, and Air, Cu. Cm. per Liter in Pure Water, at Various Temperatures and Normal Pressure (760 mm.)

Temperature, Cent.	Fahr.	Oxygen (Winkler)	Nitrogen (Winkler)	Air (Bunsen)
0	32	48.90	23.48	24.71
5	41	42.86	20.81	21.79
10	50	38.02	18.57	19.53
15	59	34.15	16.82	17.95
20	68	31.02	15.42	17.01
25	77	28.31	14.32	14.02
30	86	26.08	13.40	12.75

The methods employed by Mr. Hoopes to make use of the negative head and remove the accumulations of air are ingenious. It is unfortunate that air leakages occur to complicate the problem. Filters should be designed to remain tight under varying temperatures. One group of filter designs known to the writer leaked at the rate of 150,000 gal. daily during the summer and 1,500,000 gal. daily during the winter.

In his design for the Brisbane (Australia) filters, Hazen placed an air chamber on the effluent line and planned to remove the accumulated gases from this chamber by pumping.

The Wilmington sand analyses show a gradual coarsening of the sand at the surface of the filter, and with this coarsened layer the initial losses of head have increased with corresponding decreases in yields. This is the reverse of what one would expect and the data point to some more remote cause of the decreased capacity. It is unfortunate that sand analyses of samples taken from different depths are not available for study. A 24-in. layer of sand of an effective size of 0.33 mm. should require about one-half the initial loss of head required by a sand of 0.24 mm. effective size. Although the losses of head at Wilmington have increased five-fold in five years, it does not seem possible that these increases have any connection with the size of sand at the surface of the filter.

Robert Spurr Weston,
Consulting Sanitary Engineer.
Boston.

Sir: The article of Edgar M. Hoopes, Jr., on air-bound slow sand filters at Wilmington, Del., which appeared in the Engineering Record of Sept. 4, is of much interest. The following comments upon entrained air in rapid sand or mechanical filters may be of further interest to readers in this connection:

For air to become entrapped within a filter bed during filtration, a partial vacuum must be first established. The air so trapped, however, may have come out of solution from the water being filtered, or it may have been derived from leakage of air into the tank from the outer atmosphere. Air may come, of course, from both sources; but if air leakage is known to exist, and the air liberated is of considerable volume, it is probable that the amount coming out of solution is relatively small as compared with that which is leaking into the tank. Localized eruptions of air, when filtration ceases, would appear to be indicative of air leakage into the tank, while a general liberation of air uniformly over the whole surface might show that the air was coming out of solution in the water being filtered.

In the operation of the rapid sand filters at Cincinnati very little trouble has ever been experienced from the liberation of air within the filter beds. This is due probably to the methods of operating and to the practical absence of air leakage into the filter tanks when operating with a negative head. The tank units are divided by the central gutter so that two separate sand beds exist. The writer has seen air liberated from one side of the bed and not from the other, when the filtering process was stopped, and just as the applied wash water commenced to rise in the tank. In this case it is believed that this air is derived from leakage into the side of the tank showing the air, rather than from the water which had been filtered through that side.

Liberation of air from the filter beds occurs at this plant only during the summer months, and never during the winter months. The filtered water is always, either in winter or summer, from 0.3 to 0.5 deg. C. warmer than the applied water, the greatest difference being in the winter months. During the winter months, when the water is the most turbid, it is not possible to operate with negative heads, or at least with only very small negative heads, because of the poor quality of the effluent which would result. On the other hand, during the summer months negative heads may be safely permitted with no accompanying deterioration in the quality of the effluent.

Rapid sand filters may be so operated that they may easily become air-bound. This occurs if too great a loss of head is permitted, and if no attention is paid to a rapidly decreasing rate of filtration. The writer believes that leakage of air into rapid sand filters operating under a partial vacuum is likely to be the source of the greater proportion of the air entrained in the beds. J. W. Ellms,
Superintendent of Filtration.
Cincinnati.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

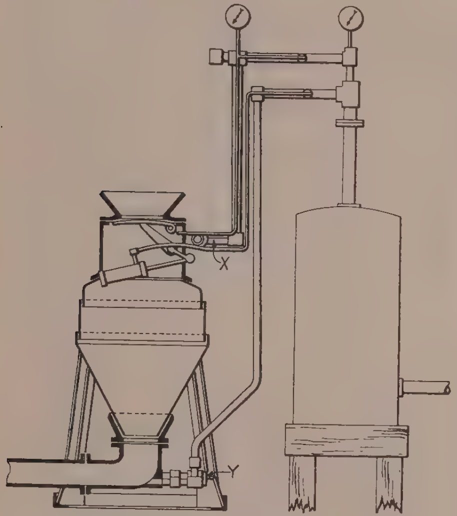
[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Proper Regulation of Air Prevents Clogging of Pneumatic Mixers

By H. A. LEEUW

Assoc. M. Am. Soc. C. E., New York City

PROPER application of an ample supply of compressed air has overcome clogging in the conveying pipe in placing concrete by the pneumatic method. This clogging has been the most serious drawback to the use of this method by mixing and placing concrete, which has developed until concrete has been placed at a distance of 2800 ft. at the Mile Rock tunnel in San Francisco, and raised to a height of 60 ft. in building piers for a bridge at Magnolia, W. Va.



HOW TO ADMIT AIR TO PNEUMATIC CONCRETE MIXER

Owing to the way in which different aggregates behave in feeding into the conveying pipe, the air has to be supplied differently for stone and gravel. The illustration shows a cross-section of the mixer and inlet pipes, which are designated by *X* and *Y*. To illustrate the above statement, when gravel is used, it has been found that it was necessary to admit air only through the inlet marked *Y*, as an application through both would cause the material to feed too fast into the conveying pipe, and would result in a clogged pipe. When stone is used, however, it is necessary to apply the air through both inlets. If only the inlet *Y* is used, the material will arch and then suddenly fall down to the discharge pipe, causing it to clog.

It is very important to have a sufficient volume of air to carry the concrete through the delivery pipe to the forms. When this has not been properly taken care of, the concrete will drop in the delivery pipe and the next batch will stick on this and clog the pipe. The tendency has been to underestimate the number of cubic feet of free air per minute required, as till lately there has been little information available on this subject. The following table shows the result of three years of study and practical experience. Present satisfactory installations are proving the correctness of these figures.

CUBIC YARDS OF CONCRETE PER HOUR, MIXER CAPACITY ½ CU. YD.

Actual amount of compressed air required. Cu. ft. of free air per minute	Length of Horizontal Discharge					
	100 Lin. Ft.	300 Lin. Ft.	400 Lin. Ft.	600 Lin. Ft.	800 Lin. Ft.	1000 Lin. Ft.
600......	20	15	10	..	..	..
800......	30	20	18	12	6	..
1200......	40	30	25	20	12	8

It has been found that the character of the sand plays a more important part, with reference to the speed with which the mixture is carried through the pipe, than does that of the stone or gravel. A sharp, clean sand will require less air to move concrete mixed with it than one in which the percentage of loam or oxide of iron is high.

It has also been found that a pressure of 90 lb. per square inch gives the best results. This pressure, expanding into a 6 or 8-in. pipe, depending on the size of stone or gravel used, is reduced to a pressure averaging about 25 lb.

HOSE AT DELIVERY END REDUCES KICK

This high pressure has presented an obstacle to be overcome, as the delivery end must be securely fastened to take care of the kick resulting from this pressure. After considerable experimenting, it has been found that a hose, the lining of which is made of pure rubber to withstand the wear, and reinforced to take care of the thrust, when connected a short distance from the delivery end, acts as a shock-absorber, and allows the discharge end to be handled, so that the concrete is not all deposited in one place, but may be distributed in even layers.

The mixture of the concrete placed in this way has been found to be as perfect as that delivered by any of the mechanical mixers on the market. When, however, the volume of compressed air falls below the amount required, as shown in the table, the mixture shows a tendency toward segregation.

The pneumatic method is well adapted to tunnel lining, as it is possible to secure an increase of at least 50 per cent in speed with a corresponding decrease in labor. Accurate cost data are difficult to get, but the following represents the average case:

	Cents per cubic yard
Labor	12
Compressed air	26
Pipe and equipment	10
Overhead	3
Cost for mixing and placing	45

The usual labor crew consists of six men for an outfit which is placing concrete at the rate of 100 cu. yd. in a 10-hr. day.

Tilting Hopper Saves Labor on Concrete Job

By GEORGE W. DAVIDSON

General Foreman, Hennebique Construction Company, Middleboro, Mass.

A TILTING hopper, simple of construction, made it possible for one man to empty all the cement for the concreting of a reinforced-concrete water tower 173 ft. high and, at the same time, to thoroughly shake and tie up all empty sacks so that none were left loose to be scattered after the day's run. The hopper, which is shown in an accompanying illustration, was built on the job, of wood, and placed on the elevated platform. One man on the platform

ONE MAN, WITH HELP OF TILTING TROUGH, HANDLED BOTH CEMENT AND SACKS emptied the cement necessary for one batch into the box. Cars loaded with the aggregates were pushed up on tracks alongside the platform. The hopper was tilted over and its contents emptied, and the car pushed on its way to the mixer. The man on the platform found ample time between cars to attend to the emptying as well as the shaking out of the bags and to pile them and tie them up in bundles as well.

Time Study Shows Expensive Defect in Cement-Handling Methods

TIME STUDIES on cement handling showed the Bridgeport Hydraulic Company that unloading took an undue length or time in hauling cement from Bridgeport, Conn., to the site of a dam under construction near that city. Automobile trucks with gondola bodies were used, being loaded and unloaded by hand. There was no reason apparent for the long time required for unloading, until the operations were studied more closely. Then it was found that in loading from the box car into the truck, the side of the truck away from the box car was filled first. The result of this was that, to such extent as the rows of cement sacks overlapped, those on the side away from the box car were wedged down. In driving up to the cement house it was found that the drivers turned this tightly-packed side of the truck next to the door, and that the unloading crew had been beginning always on the wedged side of the load. The result was that it took two men considerable time to pull out every sack in the first row unloaded. When the trucks were turned around, the sacks, of course, came out as easily and as quickly as they went in.

Things of this kind are not easily seen by the average straw boss, or even by more responsible foremen. For this reason, according to officials of the Bridgeport Hydraulic Company, time studies of this sort have proved very valuable.

Blocking of Concrete Bricks Used in Raising Steel Bridge

By R. C. HARDMAN
Colorado Springs, Colo.

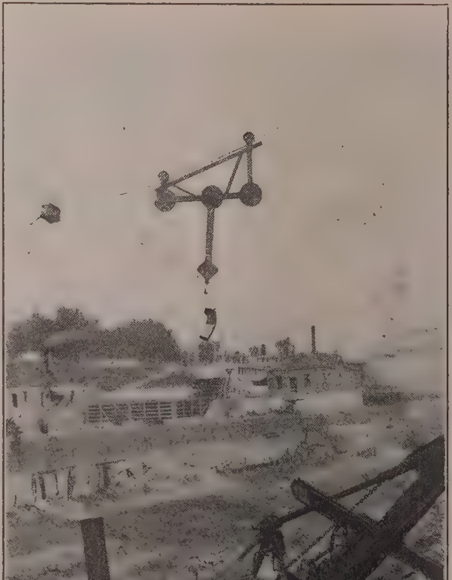
IN RAISING a heavy steel highway bridge recently to a height of 5 ft. at one end only, blocking of concrete bricks or blocks was used instead of the customary timber blocking. As the bridge was raised from above by means of slings fitting over the nuts on the end pins, it was thought inadvisable to use the ordinary blocking which would have to be removed in its entirety in order to place the permanent concrete pedestals under the bridge shoe, thus leaving the bridge suspended in mid-air until the concrete has set sufficiently to receive its load. To obviate this more or less dangerous condition concrete block piers, made of 4 x 8 x 16-in. blocks of 1:2:4 concrete, were carried up directly under the bridge shoe as it was raised. In this way, the shoe was at no time more than a few inches off a firm bearing. The blocks were of such size and shape that a great variety of course arrangements could be made so that perfect bonding could be secured. The raising of the bridge was made in short lifts of 13, 32 and 15 in., the whole time consumed being 10 hr., which was distributed over three days. At the end of each lift the space between the block pier and the pedestal form was filled with a 1:2:4 concrete, level with the top of the pier, and the bridge brought to a bearing on the pier. By this means, no load was placed upon the fresh concrete. The blocks were laid up with approximately a 1-in. bed and joints, the pier showing a slight settlement as the weight of the bridge was applied to the fresh mortar bedding. The faces of the piers were purposely left as rough as possible by raking the joints, so as to secure a good bond with the concrete poured around them. Small piers forming a bearing for the lifting jacks were built along side the larger piers and incorporated in the pedestals in the same manner.

The blocks were made on a wooden bed in sets of twenty, two hundred being made in all to allow for breakage and imperfect blocks. They were allowed to cure for a minimum of two weeks before being used. At the end of each day's run of the mixer on other parts of the work, the block form was filled from the clean-up around the mixer and the last batch run, so that the cost could not be accurately kept. Approximately, however, the blocks cost 10 cents each.

The labor cost of raising the bridge and building the pedestals and piers was $15.34, the total cost being brought up to about $49 by the cost of material and special lifting apparatus.

Single-Line Cableway Pulls Tools from Louisville Lock

FOR HAULING TOOLS and small pieces of machinery out of the excavation for the lock at the head of the Louisville and Portland canal on the Ohio River the contractor devised the single-line cableway shown in the accompanying photographs. It is operated by a single drum motor-driven hoist. The lock was described in the Engineering Record of June 26, page 796.



ONE-LINE CABLEWAY

As the outer end of the carrying line is anchored at a point considerably lower than the bank end the frame is made so that one of the trolley wheels sets higher than the other, permitting the three pulleys, through which the combined lifting and pulling line is run, to set approximately level. The carrying line is on sufficient grade and the friction in the three-part line carrying the hook block is so small that the carriage will rest against the stop until the load is raised against the catch on the carriage, which can then be pulled up the grade to the side of the pit.

The carriage was designed and built under the direction of C. H. Wright, superintendent of the Ohio River Contract Company, which is building the lock for the U. S. Government.

Safety Pointers for Handling Carbide Tunnel Lamps

ALTHOUGH carbide lamps do not give off any dangerous gases, and are not ordinarily liable to explode, accidents which might produce serious results are apt to occur with them if they are carelessly handled. James W. Paul, in a circular issued to miners by the U. S. Department of the Interior, gives several rules which should always be observed if these lamps are to be handled without risk.

Carbide should never be stored underground, and the quantity carried down by each man should be limited. If the light has to be recharged below ground, the extra carbide should be carried in an air-tight metal box having a screw top. Glass jars are not safe containers for carbide, as they are easily broken; and if carbide is put in a copper container or lamp, especially the latter, it is liable to explode. Carbide or the refuse from the lamps should not be left underground or near any inflammable material. Where carbide cap lamps are used with the carbide container fastened to the belt of the wearer, the tube carrying gas to the lamp should be carefully looked after. If it should leak, the escaping gas is apt to ignite and seriously burn the wearer.

Because of their greatly superior light in proportion to their weight, especially the lamps made with reflectors, these lamps are coming into wide use among construction men and engineers on tunnel and subway work. It need not be pointed out that the precautions suggested by Mr. Paul for miners are equally applicable to construction work.

Holes Counted as They Explode by Using Delay Electric Caps

DELAY electric blasting caps are being put to a new "safety first" use which enables a blaster to count all the holes in a round, and make sure that all have gone off, according to the *Du Pont* Magazine. In the first hole an ordinary blasting cap is put. The second hole is fired by a delay blasting cap, the third hole by a second delay blasting cap, the fourth hole by a third delay blasting cap, and so on. All the caps are on the same circuit, and all are ignited by one operation of the blasting machine. The delay caps fire the charges in order, and with a sufficient interval between explosions to permit of counting the shots, so that the men doing the blasting can tell absolutely that every charge has gone off before they return to the cut.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Rock Slides Greatest Menace to New York Subway Work

Says Report of Davis and Quimby—Engineers of Public Service Commission Report Seventh Avenue Collapse Started by Blast

That New York City's subway work is being carried on in general in accordance with the best practice, that rock slides, such as occurred Sept. 25 on Broadway, at Thirty-eighth Street, constitute the "greatest and only serious menace" to be guarded against, that cross-bracing should be used wherever there is any doubt as to the strength of the rock foundation, that the permanent construction should be kept as near as possible to the headings, and that constant inspection of the temporary street supports is necessary, are the conclusions set forth in the report to the Public Service Commission by Edmund S. Davis, chief engineer of the Boston Transit Commission, and Henry H. Quimby, chief engineer of the Philadelphia Department of City Transit, made public Oct. 6. These men were retained by the Public Service Commission to make a report on the construction methods in use, and to recommend, in view of the recent failures of subway decking, changes to insure against a repetition of either accident.

This report, in respect to the type of bracing used by the contractor on whose work the two collapses occurred, agrees with the editorial opinion expressed on page 405 of the Engineering Record of Oct. 2. The report says, in part:

"With special reference to the method used by the United States Realty & Improvement Company, in whose work the two recent casualties occurred, we found that the sizes of the material used for the various members give ample strength for the loads imposed by the street traffic, and we are of the opinion that while in some cases details of the framing and bracing were found that are not in accord with the best practice, the greatest and only serious menace to the shoring and the public safety consists in the possibility of rock slides similar to that which occurred Sept. 26 on

(*Continued to page 462, third column*)

Highest Dam Completed

To signalize the completion of the world's highest dam, the 351-ft. Arrowrock structure of the U. S. Reclamation Service's Boise project in Idaho, a harvest home festival and barbecue was held Oct. 4.

The Boise project, for which this dam stores water, embraces 240,000 acres, and settlers from various parts of the tract brought for the barbecue cattle, hogs, sheep and poultry, while others furnished fruits, grains and vegetables. Residents of the four counties, Ada, Boise, Canyon, and Elmore, including citizens from the cities, gathered for the celebration.

The dam contains 530,000 cu. yd. of concrete. Excavation was begun in July, 1912 and completed in August, 1913. Concreting was started Nov. 11, 1912.

ARROWROCK DAM, BEGUN IN 1912. COMPLETED AFTER THREE YEARS OF WORK

Commerce Commission Hears Railroads on Valuation

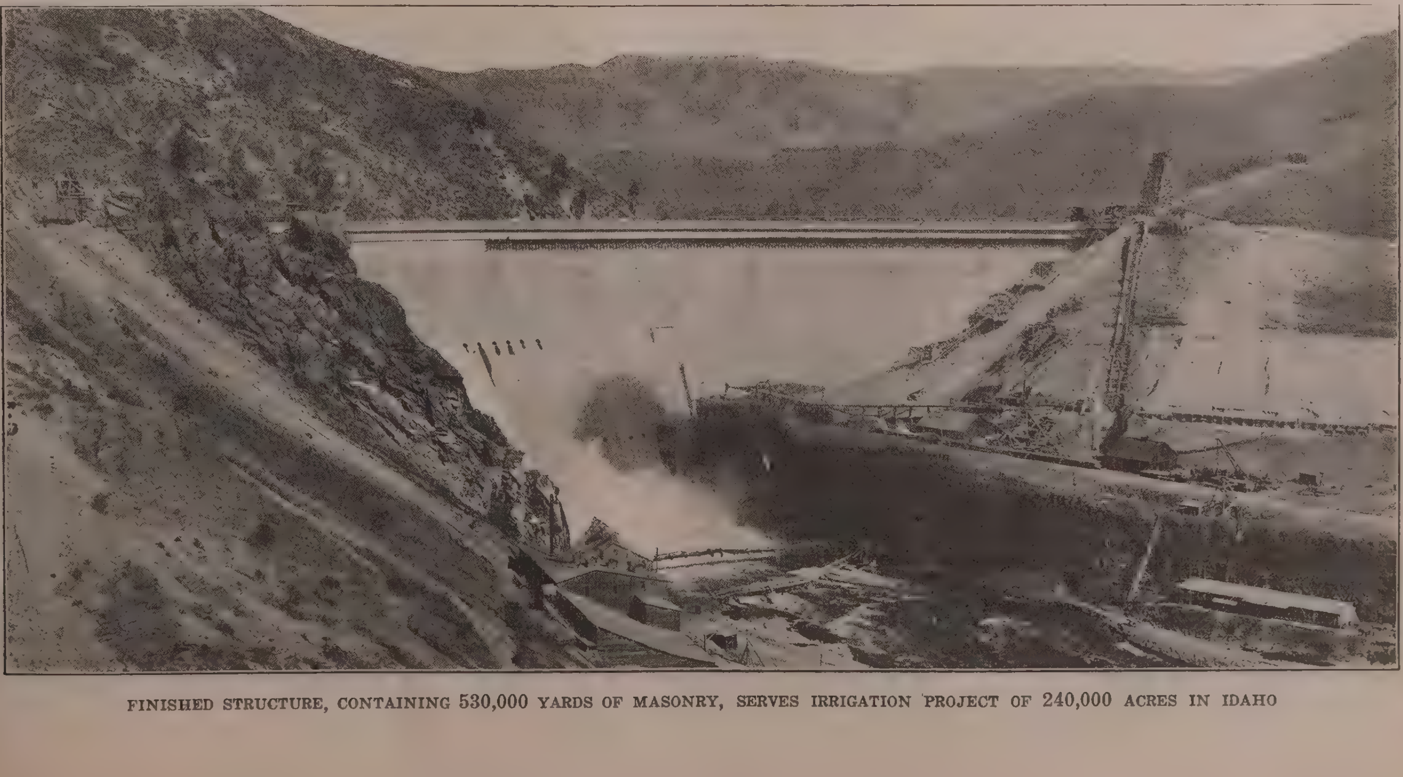
Presidents' Conference Committee Sets Forth Its Views of Fundamental Principles in Two-Day Conference at Washington

Depreciation and the so-called "intangible elements of value" proved to be the chief bones of contention at the valuation conference held by the Interstate Commerce Commission in Washington, Thursday and Friday of last week. Much attention was also given to the subject of land. Except for occasional questions by other interests which reflected their dissenting views, the railroads furnished all of the argument in the two-day session, basing their discussion on a 544-page brief previously filed with the commission. The State commissions had not prepared any formal argument.

The conference was called by the Interstate Commerce Commission to hear the views of those interested in the fundamental principles of valuation. About 125 attended—mostly railroad men, with a few representatives of State commissions. The railroads' case was presented by four of counsel for the Presidents' Conference Committee, G. S. Patterson, Pierce Butler, W. G. Brantley and Sanford Robinson. A. E. Helm of the Kansas Public Utilities Commission was the spokesman for the State commissions. The arguments of the railroads were presented under eight main heads: (1) Reasons for the Valuation Act, (2) cost of reproduction new, (3) unit prices, (4) depreciation, (5) the phrase "owned or used for the purposes of a common carrier", (6) land, (7) property charged to expenses or surplus and (8) other values and elements of value. One or two other subjects treated in the brief were not reached in the oral presentation.

Purposes of Valuation Act

Mr. Patterson, opening the discussion, said that the recommendations of the commission to Congress for the last twenty-five years indicated that the Valuation Act was deemed essential: (1) To obtain a trustworthy comparison between present value and original cost,



FINISHED STRUCTURE, CONTAINING 530,000 YARDS OF MASONRY, SERVES IRRIGATION PROJECT OF 240,000 ACRES IN IDAHO

(2) to use in rate questions, (3) in connection with taxation, (4) in determining a proper depreciation reserve, (5) in testing the accuracy of the carriers' balance sheets, (6) in standardizing railway statistics, and (7) in determining whether the railroads are under or over-capitalized. He urged that the values must be classified as well as ascertained.

Quantities and Unit Prices

Mr. Butler, discussing reproduction cost new, asserted, as the railroads held at the conference May 27-29 before the director of valuation, that this implied original topographic conditions, but construction according to present-day methods and prices and with present facilities other than the railroad itself. It also implied a construction program combining speed and economy. Briefly, then, he reviewed the main points made by the carriers last May relative to the inventory and the overhead charges. In determining quantities and classifications of materials he pointed out the need for historical data to establish facts not evident on the ground. In the question of contingencies he mentioned the use by some appraisers of contingencies of inventory as well as of construction, to take care of items bound to be overlooked.

Unit prices were discussed by Mr. Robinson. He held that "the prices to be used in the valuation should be arrived at by a consideration of prevailing prices, price tendencies and conditions affecting labor and material markets during a reasonable period of time next preceding and at the date as of which the valuation is to be made, due consideration being given to the existence or non-existence of active railroad construction during that period." "Weighted" averages, that is, averages based on unit price times volume, must be used rather than averages of prices alone, he held, inasmuch as high prices always accompany periods of heavy construction. He urged that no prices be applied, even tentatively, without full consultation with the carrier.

Depreciation

Depreciation was discussed by Mr. Brantley along much the same lines as at the May conference. He insisted that where there was no deferred maintenance there was no depreciation, that it was impossible for the numerous field men to "guess" how long a car or a bridge would remain useful. Questions put by representatives of the Government indicated that they deemed it mandatory according to the Valuation Act to record the "condition per cent" of the individual parts.

The meaning of the phrase "owned or used" was discussed briefly by Mr. Patterson, who held that the question of title was immaterial, only the use signifying; also that in the case of joint facilities each carrier should be treated as a separate entity, and all property jointly used credited to each carrier regardless of the other users.

Land

Mr. Butler, discussing land, followed the line of reasoning presented last May. He held that while the Minnesota rate decision did reject the use of speculative multipliers, it did not conflict with the railroads' views that values should be what it would now cost to acquire the land. He appealed to the Division of Valuation to examine carefully records made by the carriers' land committee in Chicago, showing the actual land costs for numerous lines recently constructed. He asserted that allowance of unearned increments was fully sustained by law.

As to property charged to expenses or surplus, Mr. Patterson stated that the doctrine excluding this was highly destructive to railroad practice. Railroad expenditures must be made at the most favorable times as regards unit prices and development necessities, which might be at the least favorable times as regards the raising of new capital.

Mr. Brantley urged the appointment of examiners to take testimony and settle disputed questions of fact prior to the reporting of any tentative valuations.

Other Values and Elements of Value

Mr. Robinson gave the same five "other values and elements of value" cited at the May conference, and, as at that time, conceded that it might be very difficult to estimate them separately, and that the railroads would not as yet undertake to say how they should be determined. Commissioner Hall asked whether these intangible values should always have a plus sign. Mr. Robinson thought they should unless it were conceded that the railroad ought not to have been built and would not be replaced if removed.

This closed the carriers' discussion. Before adjournment Mr. Helm explained for the State commissions that the recent appointment of their former designated spokesman, Milo R. Maltbie, to the staff of the director of valuation had left them unequipped to prepare a presentation of their views for the conference. He asked that the States be given a later hearing, but the Federal commission was unable to grant the request. The State commissions were therefore given sixty days to file a brief, and the carriers were allowed twenty additional days to reply to it. Chairman McChord pointed out that while the commission would not render any formal order covering the questions raised, the progress of the valuation work would necessitate orders from time to time on various matters under discussion.

Panama Canal May Be Closed a Month by Worst Slides Yet

What has proved to be by far the most serious blockade of the Panama Canal since its opening began Sept. 20 with a slide along the east bank of Gold Hill. Dredges were put to work at once, and it was first believed the canal could reopened in a week. Other slides have followed, the latest one reported occurring on the night of Oct. 2. As a result of this latest slide the Washington Bureau of the Panama Canal wired the collector of the port of New York that there were no definite prospects for reopening the canal before Nov. 1. It is stated that there are about ninety vessels at the canal entrances or in Gatun Lake awaiting passage.

It is reported that Major-General G. W. Goethals, who arrived at Panama Oct. 6, has withdrawn his resignation as Governor of the Canal Zone and will remain in charge until the condition of the canal will permit of his departure.

New Regulations Issued by Philadelphia Building Bureau

Recently issued regulations by the Philadelphia Bureau of Building Inspection in regard to reinforced-concrete construction require that the plans and specifications filed shall be accompanied by stress computations and descriptions in detail, including size, length and points of bending of all reinforcement, the qualities, proportions and methods of mixing the concrete and the dead and live loads each floor is designed to carry. No deviation of the construction from the approved plans shall be allowed except upon the written consent of the Chief of the Bureau of Building Inspection.

Every reinforced-concrete building shall be erected under the constant supervision of an inspector furnished by the owner or architect and acceptable to the Chief of the Bureau. The latter shall be empowered to stop any improper construction or cause removal of improper construction which he may consider dangerous.

Plans on file at the building shall be marked in ink to show the progress of the work and state the time and dates when concrete was deposited. The date on which the forms may be removed shall be indicated by the Chief of the Bureau, and record made of the date upon which the forms are actually removed.

Rock Slides Greatest Menace to New York Subway Work

(*Continued from page 461, first column.*)

Broadway at Thirty-eighth Street, and that the most need for reinforcement of the temporary structure is adequate support for all loose rock by providing either rakers or horizontal shoring, or by doweling into the solid rock, wherever the condition of the rock indicates liability of a stratum to separate from its bed.

"Longitudinal diagonal bracing is probably never needed except in the event of the accidental destruction of one or more of the bents, and as it is necessary to remove it before the permanent steel framework of the subway can be erected, it would seem that a continuous system of longitudinal diagonal bracing is scarcely justified.

"The lesson of the extensive collapse on Seventh Avenue, where the blast that caused the disaster perhaps directly destroyed only the nearest bents, would logically be that, as provision against the occurrence of an accident of any sort that may destroy one portion of the timbering, some diagonal bracing should be provided at such intervals as may be justified by the local conditions. If the permanent subway construction should be kept as close to the heading as is practicable and prudent, considering its liability to injury by blasts, manifestly very little of such longitudinal diagonal bracing will be needed.

"In the light of experience gained as a result of these accidents, both of which were of an unprecedented character, we make the following recommendations:

"(1) That throughout the present construction, at every point where the trench is in a rock with inclined strata, showing open seams or other evidence of actual or threatened disintegration, the sides be shored across the trench so as to form a continuous strut from side to side of the trench, with additional supports in the shape of raker braces if projecting portions of rock afford the necessary hold.

"(2) That an effort be made to systematize the work so that the sequence of operations will carry the work of excavation and the erection and concreting of the permanent subway structure close together, so as to require as little falsework and temporary decking of the street as possible.

"(3) That in future work preference be given to a type of timbering that will provide continuous needlebeams or struts from side to side of the trench, with the joints of the uprights firmly spliced to prevent buckling.

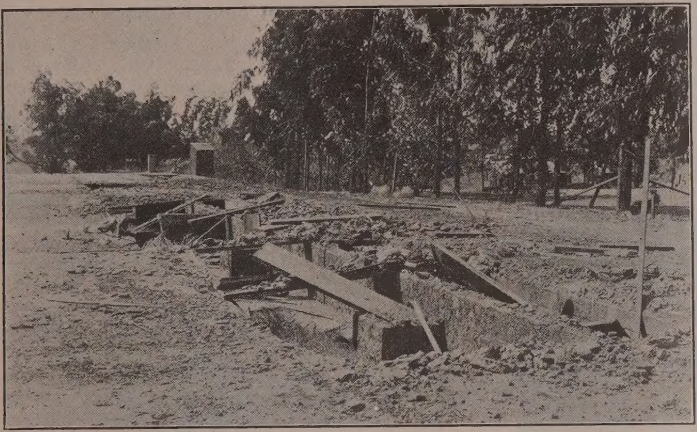
"(4) That a periodic inspection be made of every point of contact of shoring with the banks, as well as of all connections of members to insure continuous tightness and prevent deterioration of the timber work from vibration.

"In our tour of inspection we have found that, with the few exceptions noted, the work of subway construction is being prosecuted throughout in the most thorough and systematic manner. Considering the magnitude of the work and the great extent and variety of the operations, the instances of failure of any sort resulting from carelessness, or otherwise, in the conduct of it are remarkably few."

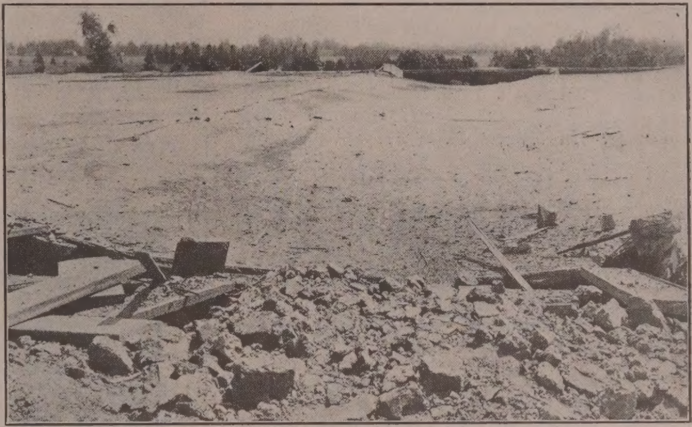
Blast Started Seventh Avenue Collapse

John F. Myers, engineer for the Public Service Commission of the second division, having charge of the section on which the Seventh Avenue collapse occurred, in reporting to the Public Service Commission on the probable cause of the accident, says:

"Looking over the work, I have formed the opinion that the blast had been the cause of the accident and that its force had caused the members forming the support of the street and trolley tracks to move to the south, and that this southerly movement was especially evident on the east side of the cut, which was that on which the blast was fired. I also felt that this movement had, in all probability, been augmented by the fact that the trolley track, having had the supports taken from beneath it, had hung in a manner similar to a rope, and that this action by either pulling the posts, which were above the cross I-beams, to the north, or else pushing them to the south, had in turn augmented the movement which I believe the blast initiated, and when this disturbance of the track reached the point where the surface car was, its weight, added to that of the track, increased the force tending to move the supporting structure southward. The car, being a north-bound one, was on the east track, upon which side of the cut, as noted above, there is most evidence of this movement. The posts supporting the cross I-beams fell with their tops to the south and their bottoms to the north."



DESTROYED SECTION OF PASADENA TANK COVERED WITH REDWOOD PLANKS



LOOKING ACROSS 114-FT. WIDTH—SLAB SAGGED ENTIRE DISTANCE

Robert Ridgway, engineer of subway construction for the Commission, in reporting on the same accident, agrees substantially with Mr. Myers, and adds that on the day of the Seventh Avenue accident the engineers of the Public Service Commission and the various contractors made, by his order, an immediate inspection of all street supports with the object of remedying whatever conditions might be found to be unsatisfactory.

Street Car Service Resumed on Broadway

The Broadway section which collapsed has not yet been redecked, but the east side of the street and the car tracks have been restored to grade, and through street car service has been resumed. Although the car tracks have been completely restored across the gap in Seventh Avenue, street car service had not been resumed by Oct. 6. The work of concreting the roof and walls of this section is being pushed, and will be completed before the street surface is restored. Both sidewalks have been opened to pedestrians at the scene of the Seventh Avenue accident, and one sidewalk at the Broadway collapse. The only blocks remaining closed to vehicular traffic are those from Thirty-seventh to Thirty-ninth Streets on Broadway and from Twenty-third to Twenty-fifth Streets on Seventh Avenue.

Damaged Pasadena Sewage Tank to Be Covered with Redwood

Because it is not considered advisable to spend any more money than is absolutely necessary on existing works until the sewage problem of Pasadena, South Pasadena and Alhambra has been settled, the roofing slab of reinforced concrete that was disturbed in the explosion of Aug. 26 will remain as it is, as it is considered that the amount of reinforcement in it makes it strong enough to last indefinitely. A roofing of redwood planks, however, will be placed over the shattered parts and this will be covered with earth to seal it and prevent odors from coming through.

The explosion was caused by a grass fire lighted by workmen on the sewer farm. About 6000 sq. ft. of the slab top was destroyed. The tank is 230 ft. long by 114 ft. wide, and on each of the two long sides there is a channel about 5½ ft. wide covered with 3 x 12 in. redwood planks, which have a dirt covering of 3 or 4 in., except at about every 15 or 20 ft., where there was a plank exposed with a ring in it to facilitate raising for examination of the sewage. The workmen had a fire completely surrounding the tank and it was apparent that the gas escaping from it was lighted simultaneously on both sides. The slab top is 3½ in. thick, reinforced with ⅜-in. rods and with an 8-in. reinforced-concrete beam at every 15 ft. At every 20 ft. along the long wall there are 8-in. reinforced-concrete walls running the short way of the tank. At the time of the explosion there was probably a gas volume of 80,000 cu. ft. Much of the slab sagged after the explosion and the retaining walls sustained fractures.

This report is based on information received from R. V. Orbison, city engineer or Pasadena.

News of Engineering Societies

The American Society of Civil Engineers held a meeting in New York City Oct. 6. John Vipond Davies presented a paper on "The Astoria Tunnel Under the East River for Gas Distribution in New York City."

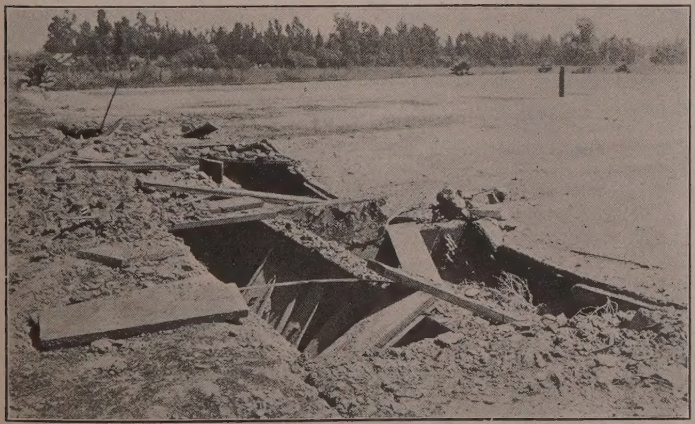
The Vermont Society of Engineers will hold a meeting at Springfield, Vt., Oct. 11-12.

The Philadelphia Association of Members of the American Society of Civil Engineers held its annual meeting Oct. 4. Dr. John A. Brashear, president of the American Society of Mechanical Engineers, spoke on "Contributions of Photography to Our Knowledge of the Stellar Universe." Officers elected for the ensuing year are: Edward B. Temple, president; Edgar Marburg and John Sterling Deans, vice-presidents; Henry H. Quimby, H. S. Smith and Col. George A. Zinn, directors; S. M. Swaab, treasurer, and W. L. Stevenson, secretary.

The Engineers' Division of the Chicago Association of Commerce has resumed its bi-weekly meetings, having held the first one Oct. 8 as a get-together session to discuss plans for future activities. Edmund T. Perkins is chairman of the division.

The Illinois Section of the American Waterworks Association will hold a one-day meeting in Chicago Oct. 19. During the afternoon the members will inspect the Wilson Avenue tunnel, the municipal shops and the municipal pier, all in the course of construction. Following a dinner at the Sherman House S. A. Greeley will speak on "Water Softening for Municipalities" and John Ericson will describe the construction of the Wilson Avenue tunnel and steel intake crib.

The Engineers' Club of Philadelphia will hold a meeting Oct. 19. Edward Wegmann, consulting engineer of New York City, will present a paper on "Ancient and Modern Water Supplies."



ONE OF THE WALLS ON THE WEST SIDE THAT WAS BADLY DAMAGED

VIEW DIAGONALLY ACROSS TANK GIVES AN IDEA OF ITS EXPANSE

Personal Notes

Frederick E. Morrow, formerly principal assistant engineer of the Chicago & Western Indiana Railroad and the Belt Railway Company of Chicago, has been appointed assistant chief engineer. Mr. Morrow was graduated from Purdue University in 1904. From June to November of that year he was in the engineering department of the Illinois Steel Company, which service he left to enter the engineering department of the Chicago & North Western Railway. He was successively rodman, instrumentman and assistant engineer with that road until April, 1907, when he was appointed field engineer in the division of track and roadway of the Board of Supervising Engineers, Chicago Traction. In April, 1910, he entered the Chicago & Western Indiana organization as office engineer. In March, 1913, he was promoted to be principal assistant engineer, in which position he had charge of the construction work of both the Western Indiana and Belt Railway, including the recently completed Clearing Yard.

W. H. C. Ramsey, formerly connected with the Johnstown (Pa.) Water Company, has been appointed general manager of the York Water Company.

R. H. Stoddard, constructing engineer, of Portland, Ore., has been engaged by Le Doux & Le Doux of Portland to supervise the construction of the $100,000 temple for the Pocatello Elks, at Pocatello, Idaho. Mr. Stoddard made the structural designs for the building, which will be devoted exclusively to lodge purposes.

Abram B. Dunning, who has recently been engaged in work for the Du Pont Land and Railway Company at Deland, Fla., has returned to Scranton, Pa., where he will assume practice as consulting and designing engineer.

W. J. Sherman Company, consulting engineer, of Toledo, Ohio, has been retained to conduct investigations and make recommendations, accompanied by preliminary estimates of cost, for the development of an increased water supply for the city of Salem, Ohio.

J. D. Stokes, of Baker, Fla., has been appointed county surveyor of the new county of Okaloosa.

J. P. Walker, formerly assistant engineer of the valuation department of the Atlantic Coast Line, at Petersburg, Va., has been appointed assistant superintendent of the Charleston division, with headquarters at Charleston, S. C.

Augustus W. Jones, formerly connected with the Robert Grace Contracting Company of Pittsburgh, has been appointed vice-president and general manager of the Carter Construction Company of St. Louis.

W. P. Danford, formerly city engineer of Durant, Okla., has been appointed assistant State engineer in the Oklahoma State Highway Department, with headquarters at Oklahoma City.

P. M. Fogg, formerly engineer in the U. S. Reclamation Service, has entered into partnership with E. E. Miller, consulting mining engineer, First National Bank Building, Denver, Col. Mr. Fogg was graduated from Swarthmore College in 1901 and began his professional work on the forces of the Pencoyd Iron Works. From this work he went to the Bureau of Filtration of the city of Philadelphia in 1901. From 1903 to 1906 he was engaged in drydock construction, and power house and shop erection work for the U. S. Navy at the League Island Navy Yard. He entered the Reclamation Service in 1906 as assistant engineer.

Philip E. Lacey, formerly city engineer of Bradentown, Fla., has been appointed district engineer of the Fifth District, De Sota County, Fla. In his new office he will have charge of road construction to a value of several hundred thousand dollars.

Charles H. Foote, contractor, specializing in cement and concrete construction, of Clifton, Ariz., has been appointed inspector for the Board of Trustees on the construction of the new Union High School at Duncan, Ariz.

J H. Prior, formerly assistant chief engineer of the Illinois Public Utilities Commission, has been appointed chief engineer, with headquarters at Springfield. He received his professional education at the Armour Institute of Technology and the University of Chicago. From 1905 to 1914 he was engineer of design of the Chicago, Milwaukee & St. Paul Railway, engaged in the design of all the structures of that company and on its 2000-mile extension known as the Puget Sound lines. In this capacity he made two of the earliest valuations of railroad properties required by railroad regulatory and taxing bodies; the valuation of structures of the Chicago, Milwaukee & St. Paul for the first Minnesota valuation in 1907 and the first South Dakota valuation in 1907. He was appointed assistant chief engineer of the Illinois Public Utilities Commission about a year ago.

New Chief Engineer of Illinois Public Utilities Commission

J. H. PRIOR

Guy K. Dohner has been appointed to a position on the engineering forces of the Atchison, Topeka & Santa Fé Railway.

Karl R. Kennison, formerly principal assistant engineer to John R. Freeman, consulting engineer, of Providence, R. I., has been appointed assistant engineer on the staff of the Providence Water Supply Board. Mr. Kennison received his engineering education at Massachusetts Institute of Technology, from which he was graduated in 1908. From that date until 1909 he was in the inspection department of the Associated Mutual Fire Insurance Companies. During the interval between that work and the present appointment he was mostly in the employ of Mr. Freeman, engaged on various works, including the preliminary studies for the Mississippi River Power Company's development at Keokuk, Iowa, the Medina Irrigation Project in Texas and the Hetch Hetchy Water Supply for San Francisco.

Samuel Murray, formerly bridge engineer of the Oregon-Washington Railroad & Navigation Company, has been appointed chief engineer of that company, succeeding J. R. Holman, whose retirement on account of his health was noted in these columns, Sept. 11. Mr. Murray was graduated from the University of California in 1902 and entered railway service in September of that year as draftsman for the Southern Pacific at San Francisco. He continued in that service until 1906, when he was appointed chief draftsman in the office of John D. Isaacs, consulting engineer to the company, in charge of estimates and designs of railroad structures. Previous to his connection with the Oregon-Washington company he served as bridge engineer on the San Pedro, Los Angeles & Salt Lake Railroad.

A. H. Smith and L. A. Boulay, consulting engineers, of Toledo, Ohio, who have been associated in business under the firm name of Smith & Boulay, Nasby Building, Toledo, for the past five years, will hereafter practise separately. The former will conduct business under the name of A. H. Smith Company, consulting engineer, Nasby Building, Toledo. The latter will be located in the Nicholas Building, and will continue in practice under the name of L. A. Boulay Company, civil and sanitary engineer.

Calvin W. Hendrick, formerly chief engineer of the Sewerage Commission of Baltimore and consulting engineer to the city, has been appointed chief engineer of that city. He first engaged in engineering work in 1881 as transitman on the Chesapeake, Ohio & Southern Railway. After seven years spent in railway work he became city engineer of Macon, Ga., which office he held until 1894. In 1895 he joined the staff of William Barclay Parsons, consulting engineer, of New York City, as assistant engineer on the preparation of plans for the Rapid Transit Railway Commission of that city. In 1898 he became engineer of sewers for that commission. Dr. Ira Remsen, a member of the Baltimore sewerage commission, in an address on the occasion of Mr. Hendrick's retirement from the commission, complimented him highly on his work as "builder of the new Baltimore sewerage system."

W. S. Cone, who has been for two and one-half years chief of the electrical division of the United States Reclamation Service Salt River project, has been appointed project manager to succeed C. H. Fitch.

A. N. Kelley, irrigation manager for the Yuma project, has tendered his resignation to become effective Sept. 30.

Paul R. Parker has resigned from the office of chief engineer and works manager of the Yuba Construction Company of Marysville, Cal., to take charge of the equipment and operation of the Tin Bentong Wo Liability Company, an Australian tin dredging firm, with headquarters at Penang, Strait Settlements.

Fred W. Lepper, superintendent of construction in the office of the supervising architect, U. S. Treasury Department, has been transferred from the supervision of the new post office building at Augusta, Ga., to take charge of the construction of the new building for the Department of the Interior at Washington, D. C. This structure, which will cover a lot 400 ft. on each side and will be seven stories high, will cost about $2,000,000. It is to be completed by Dec. 31, 1916.

R. M. Briner, formerly assistant engineer in the office of the supervising engineer of the U. S. Reclamation Service, at Great Falls, Mont., has been appointed draftsman for the Baldwin Locomotive Works on work in connection with the new buildings being erected by that company at Eddystone, Pa.

A. Kempkey, consulting engineer, of San Francisco, has moved his office from the Balboa Building to the Hobart Building.

Herman L. Wittstein, efficiency engineer of the Knox Motors Company, Springfield, Mass., has resigned from that office to become assistant to the management of the Standard Fuse Corporation at Paulsboro, N. J.

James P. Nelson, a member of the valuation committee of the Chesapeake & Ohio Railway, has been placed in charge of the engineering work of that committee.

J. C. Gardner has been appointed chief engineer of the East & West Coast Railway, with headquarters at Bradentown, Fla.

Perry Barker, fuel engineer, has opened offices and laboratories in the Oliver Building, Boston.

F. C. French, formerly designing engineer for the Anaconda Copper Mining Company, at Anaconda, Mont., has returned to Salt Lake City, where he was previously engaged in practice as consulting civil and mining engineer, and will open offices shortly for the purpose of resuming his practice there. He was graduated from Iowa State College in 1896 and served from then until 1899 as county surveyor of Humboldt County, Iowa, as rodman with the Iowa Central Railway, as leveler with the U. S. Geological Survey and as transitman with the Copper Range Railway successively. In the latter year he was appointed transitman on the forces of the Chicago & Northwestern, and, in 1901, assistant engineer in charge of single track construction in Wisconsin. Later he had charge of the surveys and cost estimates for the track elevation of the company's Mayfair Cut-Off in Chicago. He left this service in 1902 to become resident engineer for the Atchison, Topeka & Santa Fé, in which capacity he had charge of the construction of 25 miles of single track in Oklahoma and New Mexico. In 1903 he joined the faculty of Iowa State College as assistant professor of civil engineering, in which office he remained until 1906. During this period he was also associated with Dean A. Marston in the design of a water distribution system for Ames, Iowa and a waterworks system for West Side, Iowa. In January, 1907, he went to the Philippine Islands as senior inspector for the Philippine Railways, in charge of 100 miles of construction for the Government on the Island of Cebu. He returned to this country in the fall of that year and was appointed associate professor of civil engineering in the University of Utah. For the past three years he has been connected with copper mining properties in the Butte district, Mont.

R. B. VanSickle has resigned from the office of New York manager for the Casper Ranger Construction Company of Holyoke, Mass., to become assistant superintendent for Jacob A. Zimmerman & Sons, Inc. of New York City, on the construction of the new cotton warehouses and terminals at New Orleans, the design of which was described on page 402 of the March 27 issue of this journal.

E. B. Gore of Austin, Tex., has been reappointed as a member of the Texas State Board of Water Engineers by Governor Ferguson for a six-year term.

Robert L. Brunet, formerly public service engineer of the city of Providence, R. I., has been made head of the new department created by the City Council, Oct. 4, to have charge of all public service engineering work.

Alexander J. Taylor has resigned from the office of city engineer of Wilmington, Del., to enter the service of the E. I. du Pont de Nemours Powder Company. He was graduated from Delaware College in 1893 and has been in the city service at Wilmington since that time.

Edgar M. Hoopes, Jr., formerly chief engineer of the water department of Wilmington, Del., has been appointed city engineer, succeeding Alexander J. Taylor, whose resignation is noted elsewhere in these columns.

Edward S. Smith, formerly State highway engineer of Idaho, has been retained as chief engineer of the proposed Yellowstone Park Highway, connecting Yellowstone Park with the existing State highway system. The work will be constructed jointly by the U. S. Forest Service, Fremont County and the State of Idaho, assisted by contributions from Mrs. E. H. Harriman, the Guggenheims and others. The road will be 60 miles in length. It is expected that the surveys will be completed by Nov. 1, so that construction may be started in the spring in order that it may be ready for the summer automobile tourist travel. Mr. Smith received his professional education at the University of Iowa and served on the U. S. Geological Survey and on the engineering forces of various railways until 1904, when he was appointed city engineer of Bloomfield, Iowa. In 1906 he returned to railroad work, in which he continued for four years. In 1910 he was appointed city engineer of Gooding, Idaho, and also engaged in private practice as irrigation engineer. He left this work to become State highway engineer, from which office he resigned, June 1, of the present year.

R. W. Kniskern, formerly superintendent for the Thompson-Starrett Company of New York City, in charge of the completion of the Equitable Building, has become a member of the firm of Knap & Kniskern, building contractors, 520 Marquette Building, Chicago.

Robert F. Olds, formerly civil engineer and superintendent in the Quartermaster's Department, U. S. Army, has resigned from that service to engage in consulting practice, along structural and hydraulic lines, with offices at the Mills Building, El Paso, Tex. He was graduated from the University of Maine in 1906 and served as draftsman in the frog and switch department of the Pennsylvania Steel Company until 1907, when he became instructor in geometry and surveying at Pennsylvania State College. Later in the year he joined the staff of Charles W. Fenn, civil engineer, of Portland, Me., in charge of field work in connection with the valuation of the plant of the Portland Water Company and on the survey and plan for a pipe line 18 miles long. He was appointed civil engineer in the Quartermaster's Department, U. S. A., in 1909, and, in that capacity, has been engaged on the construction of waterworks, barracks, officers' quarters, magazines, warehouses and other buildings in various parts of this country and in the Philippine Islands.

Theodore F. Brown, assistant auditor of the Star Union Line of the Pennsylvania system, was retired from active service, Sept. 1. He entered the service of the company, on the engineering forces, in 1860.

E. G. Hopson, formerly supervising engineer of the United States Reclamation Service at Portland, Ore., has been appointed consulting engineer by Secretary of the Interior Lane. Mr. Hopson is retaining the same offices at the Central Building, Portland, and, in addition to such engineering work as may be required of him by the Government, will engage in a general consulting practice, dealing particularly with hydraulic problems.

Robert M. Cooksey, principal assistant engineer of the paving commission of the city of Baltimore, has been appointed highway engineer of that city. He has been engaged in engineering work since 1900, for the past eleven years with the city of Baltimore. He was appointed principal assistant engineer to the paving commission in 1913

L. M. Lawson, formerly project manager of the Rio Grande Irrigation Project of the U. S. Reclamation Service, has been transferred to the same position on the Yuma project at Yuma, Ariz.

Charles H. Preston, Jr., consulting engineer, of Waterbury, Conn., has tendered his report to the manufacturers of the Naugatuck Valley on the feasibility of conserving water on a large basis in the upper Naugatuck drainage basin for equalizing the stream flow. The project, if completed, will be the largest undertaking of its kind in New England, entailing a cost of several million dollars.

Civil Service Examinations

United States.—Non-assembled examinations will be held Nov. 2 to secure eligibles for senior positions, grade 2, in the Federal valuation work under the Interstate Commerce Commission. The examinations are for senior civil engineer, senior structural engineer, senior architect, senior signal engineer, senior mechanical, senior electrical, senior telegraph and senior telephone engineer. In each case the salary limits are $1,800 and $2,700 per annum. All applicants must be 25, but less than 45; they must have had not less than four years of preliminary or apprenticeship training, or must be graduates of recognized technical schools, and must have had at least four years' experience in the work indicated by the title of the position. Acquaintance with methods of inventorying and cost-estimating of railway property is desirable, and applications must show that the applicant is "a person of good moral character and temperate habits, active, intelligent and discreet; of good speech and manner, qualified to address and confer with railway and public officials as occasion may require." Persons desiring any of the examinations should at once apply to the U. S. Civil Service Commission, Washington, D. C., or to other designated officials, for form 2039, stating the title of the examination for which the form is desired.

Attention is called to the fact that the junior examinations announced in this column last week are also for the Federal valuation work. Through an inadvertence on the part of this journal this point was not mentioned.

Illinois.—The recent inauguration of a sanitary engineering bureau in conjunction with the Board of Health has created several important engineering positions in this department. One of these on which announcement has been made is:

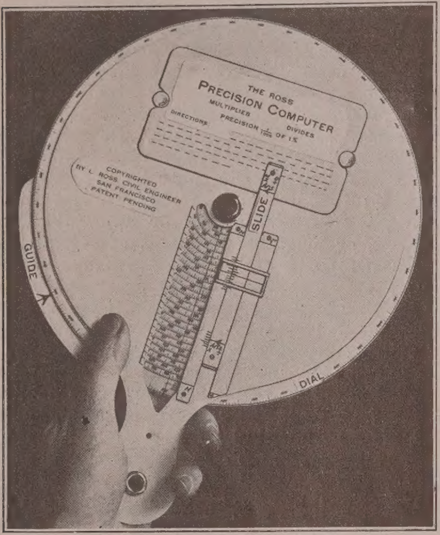
CHIEF SANITARY ENGINEER, salary from $250 to $500 a month, examination for which is to be held Nov. 6, application form to be on file Oct. 30. Candidates must be at least 30 years old and graduates of an engineering college. They should have five years' experience in a responsible position relative to sanitary work, as well as a thorough knowledge of the geography of Illinois. The duties of this position include the work of examining projects for water supply, sewage, garbage and other waste-disposal plants and investigating sanitary conditions of cities and rural communities, buildings, public and private institutions, etc.—in fact, the duties cover all work that might properly be expected of a sanitary engineering service.

St. Paul, Minn.—The Civil Service Bureau announces that examinations for the positions of junior civil engineer and two civil engineering draftsmen will be held Oct. 22, open to residents of St. Paul. Candidates for the first office must be 21 years old and graduates of a technical school, trained in the essentials of civil engineering. For the other two positions candidates for one must be 18 years old and for the other 21 years, the salaries being from $50 to $80 a month and from $85 to $100 a month respectively.

Examinations Previously Announced

Date		See Eng. Record
Oct. 13	—Aid, U. S. Bureau of Standards. Civil engineer and draftsman, Navy Department. Engineer, Indian Service....	July 3
Oct. 20	—Junior civil, junior structural, junior mechanical, junior signal, junior electrical engineers and junior architect, Federal valuation work, Interstate Commerce Commission, United States	Oct. 2

Computer Devised to Combine Quickness with Accuracy



COMPUTER IS SIMPLE OF OPERATION

The Ross Precision Computer, invented by Louis Ross, consulting engineer, of San Francisco, and manufactured by the Computer Manufacturing Company, 25 California Street, San Francisco, was devised with a view to combining the accuracy of logarithms with the speed and convenience of a slide rule. It is claimed to solve expressions in which addition, multiplication and subtraction are involved with an accuracy of 1/1000 of 1 per cent. The system of graduations is uniform throughout, and is very simple. The length of scale is 120 times as great as that of the A and B scales in the ordinary 10-in. slide-rule. Though but 8 in. in diameter its scales are equivalent to those of a slide-rule over 100 ft. long. The Precision Computer has been devised to carry out computations to 5 decimals and to combine in the same instrument means for obtaining instant approximate results where desired. It consists of a finely graduated dial, with two radial indicators and a self-reading slide adjacent to one of the indicators. The dial gives an accuracy of 5 figures, while the slide gives instant results to an accuracy of about 3 figures. For approximate calculations the slide is sufficient for precise results, to a fine degree of accuracy; the dial is used, and the slide co-operates with it to check the result, to point out the precise answer under the slot-line, and to locate the decimal point in the answer. The dial gives numbers to an accuracy of five significant figures, the first three, as printed, the fourth by counting spaces, and the fifth by estimating tenths in the last fractional space. This system holds throughout the whole scale. To solve a proportion, the radial indicators are set over any two given numbers on the dial. Their position then represents the ratio of these numbers. The indicators are kept stationary and the dial is turned to bring any third number under one indicator. The number under the other indicator will be the fourth term of the proportion. By setting the data on the slider, a pointer shows the exact loop on which to read the answer. In simple multiplication or division the operation is identical, excepting that one of the three numbers is unity. The exact manipulations for setting the given numbers conveniently are given on the face of the computer.

At the left of the slot is a scale of equal parts. This co-operates with a similar scale at the extreme rim of the dial to give directly 5-place logarithms and anti-logarithms, without requiring any mental interpolation or effort. On the dial all the data and answers are always set and read under the slot-line, and at no other point, thus obviating doubt or ambiguity. To multiply and divide any series of numbers it is only necessary to set each of the numbers in succession under the slot-line. When the last number has been set the answer will appear under the slot-line. It is not necessary to read partial or intermediate answers in continuous proportions. Powers, roots, and other complex operations may be carried out either approximately by the use of the slide alone, or to a high degree of precision by using the dial.

The Precision Computer is made of metal throughout. The graduations are engraved on silvered metal surfaces like a surveyor's compass or transit. It is slightly over 8 in. in diameter and weighs less than a pound. The instrument is packed securely in a flexible case.

Combination Crowding Feature of New Revolving Shovel

The horizontal crowding motion said to be most desirable for making shallow cuts and tearing up paving is combined in the new Thew combination boom shovel with a shipper-shaft mechanism which also gives a jack-shaft crowding that enables the shovel to dump at wide radius and considerable height in handling trench and other kind of excavation.

The two crowding mechanisms are independent and non-interfering. Both are operated from the same crowding engine, which is simply changed in position. When using the horizontal crowding motion the long dipper handle must be removed, and when the shipper-shaft crowding motion is in use, the short dipper arm is chained to the boom structure after removing the dipper. All changes necessary can be made in less than three hours. The same dipper may be used with either crowding mechanism, but a special sewer trench dipper is furnished if desired.

The long dipper handle used in connection with the jackshaft crowding mechanism is made of a single piece of wood, 8 in. square, armored with steel plates and equipped on the under side with steel racks. These arms can be had in several lengths to suit the requirements of different kinds of work, depending on the depth of trench, dumping radius, or height of lift desired. The single dipper stick, in connection with the design of the boom, affords a combination thought to be unusually strong and effective. It is said that the single stick is less liable to get out of alignment or bow out of shape, besides being lighter and stiffer than a boom constructed in two parts.

The trussed and reinforced boom on the shovel is attached to the turntable by wide hinge castings, providing strength and rigidity. When the dipper is lowered into a trench, the dipper stick passes down between the side members or dipper-arm guide of the combination boom, thus distributing any side thrust encountered. This combination shovel affords the contractor a machine with which, it is plain, he can handle practically any kind of work encountered. Either kind of crowding motion may be incorporated when the machine is purchased, and the other mechanism may be purchased and added as occasion requires at a later date. A number of these machines have been in use for several months. Literature describing this new shovel will be sent by the Thew Automatic Shovel Company of Lorain, Ohio, to any one interested.

Business Notes

The Chicago Builders' Specialties Company, of Chicago, has moved its offices to the Lumber Exchange Building, 11 South La Salle Street.

The Fibre Conduit Company of Orangeburg, N. Y., has moved its New York City office to 101 Park Avenue.

The Marsh-Capron Manufacturing Company, manufacturer of concrete mixers, of Chicago, Ill., has moved its offices to the Lumber Exchange Building, Chicago.

W. E. Hardy, formerly connected with the Diamond Rubber Company and the B. F. Goodrich Company, in charge of their sales of mechanical rubber goods division, has been appointed sales manager of the Boston Belting Company, manufacturer of mechanical rubber goods, of Boston, Mass.

The Asbestos-Protected Metal Company, of Pittsburgh, has moved its Detroit office from the Chamber of Commerce Building to the Dime Bank Building instead of the Dunne Bank Building, as stated in these columns Oct. 2.

Trade Publications

The following companies have recently issued trade literature:

Phoenix Manufacturing Company, Eau Claire, Wis. Pamphlet, 7¾ x 11¼ in., 12 pages, illustrated. Covers the construction and operation of the "Centiped" tractor truck.

Novo Engine Company, Lansing, Mich. Folder 209, 3½ x 6½ in., illustrated. Hoisting outfits, D. H. type, equipped with single and double drums and single-speed, reversible and non-reversible engines. Double platform material elevators for building construction.

Central Supply Company, Minneapolis. Folder 307, 3¼ x 6 in., illustrated. Compares Byers black wrought-iron pipe with galvanized steel, shows advantages claimed, and illustrates specimens taken from pipe lines that have been in actual service many years.

Blaw Steel Construction Company, Pittsburgh. Folder 3½ x 6¼ in., illustrated. Shows many uses to which Blawforms have been put; Ashokan dam, New York subway system, sewer, curb, building and wall construction are included. Accompanying the illustrations is a brief description of Blawforms and their advantages.

NEW SHOVEL CAN BE USED FOR BOTH DEEP AND SHALLOW CUTS